

THE MOLTING OF BIRDS WITH SPECIAL REFERENCE TO THE
PLUMAGES OF THE SMALLER LAND BIRDS OF EASTERN
NORTH AMERICA.

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The lack of definite information regarding the seasonal plumages of our birds which characterizes most of the works on North American ornithology, as well as the scarcity of recorded facts relative to the methods by which the plumages are assumed, must have impressed all who have had occasion to seek for information upon these subjects. This is unquestionably due, in a great measure, to the scarcity, in collections, of molting specimens and adults in fall or winter plumage. Molting specimens are only to be obtained during July and August in this latitude, and collecting at this season is not only difficult on account of the retiring habits of the birds during the period of molt, but also exceedingly unpleasant, being the height of our hot season. Furthermore, professional collectors have not been encouraged to collect molting birds since the most marketable specimens are full-plumaged spring birds. To this cause, too, is probably due the great scarcity of North American birds from the tropics, showing the progress and nature of the early spring molt, since collectors visiting these regions have paid more attention to securing fine specimens of the native species.

In view of the state of our knowledge of molts and seasonal plumages and the scattered nature of the literature bearing upon the subject, I have prepared the following pages, more with the hope of attracting attention to this branch of ornithological investigation, than of assuming to present a finished treatise.

For some years past I have been paying special attention to the acquisition of a series of molting specimens of our eastern North America birds and my own collection, together with that of the Academy of Natural Sciences of Philadelphia, furnishes a considerable amount of such material. I have also examined a large number of specimens in the United States National Museum, and additional series have been kindly loaned by Mr. Robert Ridgway of the above institution, Mr. Wm. Brewster, of Cambridge, Mass., and Dr. J. A. Allen of the American Museum of Natural History.

In spite of this, however, I have frequently been confronted with questions which can only be settled by the acquisition of additional

material. Owing to this lack of specimens, I have no doubt that alterations will have to be made in my accounts of the molt in several species, in the light of future investigation. I nevertheless think it desirable to publish, at once, such information as I have collected, as a basis for future work.

In the first part of this paper will be found a general account of the methods of plumage change, based upon my studies, and all statements will be understood to refer only to the groups here under consideration. As no general paper on molting has appeared recently, it seemed best to treat the subject at some length in this connection; but it must be understood that I do not claim originality for all the statements given below as many of the facts have long been known. I have, however, made no statements that have not seemed to be verified by my own investigations. The second part consists of brief accounts of the molts and seasonal plumages of most of the smaller land birds of eastern North America, from the Cuckoos through the Passeres in the order of the American Ornithologists' Union Check List. The Raptores, Columbæ, Gallinæ and all the Water Birds have been omitted for want of sufficient material for their proper study, though they will probably exhibit still more interesting facts than those furnished by the groups here under consideration.

The difficulties that present themselves in a study of this nature are many. Chief among them is the impossibility of telling the age of most of the specimens upon which we must base our investigation. The study of live birds is, of course, out of the question, and even were it possible the results would not prove satisfactory, as it has been shown that plumage changes in captive birds are often abnormal.

Thrown back upon a study of prepared skins, our only method of telling what year in the life of the bird a certain plumage represents, is by having a sufficient series of specimens, taken while actually in the molt, to connect the various known plumages. Such series are at present very hard to obtain, as has already been stated, and we are, therefore, often forced to judge from comparison of series taken before and after the molts, which is of course much less satisfactory. Many specimens, however, which are apparently not molting, often show traces of an old plumage which has just been lost or a new one just appearing, when the feathers are carefully raised on various parts of the body; and much of my information has been gained from such specimens.

It is generally considered, and in many cases actually proven, that the most perfect and brilliantly plumaged individuals of a species are the oldest, or at least are birds of several years of age, and I have followed this idea in treating of the species in the latter part of the present paper. It is, however, quite likely that certain individuals, whether from excessive vitality or some other cause, assume the adult dress at an earlier period in their life than others and that certain other individuals never attain the highest development of plumage coloration exhibited by the species.

The scarcity of adult birds in winter plumage (*i. e.* the dress assumed at the end of the breeding season) has already been mentioned. The fact that the number of these birds taken in September and October is often so remarkably small as compared with the birds of the year, seems to me good evidence that they not only start on their southward migration sooner than the young, but that they make a more continuous journey with fewer and shorter stops.

The difference in the numbers of these birds taken by autumn collectors is real and not imaginary. Mr. C. W. Beckham in 1887 called especial attention to it¹, giving the above explanation. He stated that between Sept. 1 and Nov. 22, 1886, he collected 367 birds of which 348 were birds of the year, the determination of age being based upon examination of the skeleton. In the fall series that I have examined, where the difference between the bird of the year and adult was clearly indicated by the plumage, I find the proportion of old birds very small; but I think that careful collecting carried on through August will result in the discovery of a large number of adult birds present at that time, which leave before the usual fall collecting begins.

As a result of the studies given in detail farther on, the following generalizations may be made:

- I. The annual molt at the close of the breeding season is a physiological necessity and is common to all birds.
- II. The spring molt and striking changes of plumage effected by abrasion are not physiological necessities and their extent is dependent upon the height of development of coloration in the adult plumage, and does not necessarily bear any relation to the systematic relationships of the species.

It naturally follows that closely related species may differ materially in the number and extent of their molts, and that

¹ Auk, 1887, p. 79.

males and females of the same species differ greatly in this respect when the nuptial plumage of the adult male is highly developed as compared with that of the female or with its own winter plumage.

- III. The amount of change effected in the plumage at any particular molt varies considerably in different individuals of the same species and sex.
- IV. Some species which have a well marked spring molt in their first and second years may discontinue it afterwards, when the adult plumage has once been acquired. And, on the other hand, some individuals may continue to molt in the spring, while others of the same species cease to do so.
- V. The remiges are molted less frequently than any other part of the plumage. As a rule, they are only renewed at the annual molt (exception *Dolichonyx*).
- VI. Variability in the order of molt in the remiges and presence or absence of molt in the flight feathers at the end of the first summer are generally family characters *i. e.*, *Ceryle* differs from any other species treated of in this paper in the order of molt in the primaries. All Picidæ and all Icteridæ except *Icterus*, (and *Dolichonyx*?) molt the flight feathers with the rest of the first plumage. None of the Oscines except Icteridæ (as above), some (all?) Hirundinidæ, *Otocoris* and *Cardinalis* molt the flight feathers at this time.

Some other exceptions to the above statements no doubt occur, but they cover the vast majority of cases.

In connection with the second statement attention should be called to *Ammodramus sandwichensis savanna* which has practically the same plumage at all seasons, but which has an extensive molt of the body plumage in spring. *Melospiza fasciata*, which closely resembles it in plumage at all seasons, has scarcely a trace of spring molt. *Ammodramus caudacutus* is the only other species that shows any considerable spring molt, and in which the sexes are not strikingly different.

As stated above, the number and extent of the molts do not of necessity bear any relation to the systematic position of the species. The Fringillidæ include species which exhibit the simplest series of molts as well as some examples of the most complicated molting known among the Passeres. The species of certain families do show practical uniformity in their molts, but in such cases there is also uniformity in the relative development of plumage of the sexes.

The Icteridæ exhibit the greatest number of exceptions to the general rules of molting and are more complicated in their molts than any other family. In most families complicated molting is the exception, in the Icteridæ it is the rule.

ORDER OF MOLT.

The molt is occasioned by the growth of new feathers from the old papillæ, each new feather forcing out the old one on its tip. The point of attachment, however, is so brittle that the old feather is almost immediately broken off, but in young birds molting from the first plumage into their winter plumage, the old feathers are not infrequently found still attached to the tips of the new ones. A young Meadow Lark, *Sturnella magna*, in my collection shows this very nicely, and Mr. William Palmer² mentions a young Hooded Warbler, *Sylvania mitrata*, in which the down of the nestling was to be seen at the tip of the first-plumage feather while it was in turn attached to the new feather of the winter plumage (Pl. IV, figs. 5, 6).

The feathers are, of course, not all shed at once, but the new feathers on certain parts of the body have nearly completed their growth before those on the other parts make their appearance.

The first body-feathers to appear, in our passerine birds at least, are those of the abdominal tracts, forming a conspicuous V-shaped patch against the old plumage of the rest of the lower surface. Almost coincident with these appear the feathers of the interscapular region and shortly afterward those of the throat and crown; there is, however, a good deal of variation in the order of appearance of the other body feathers (in fact, of all, after the development of the abdominal tracts) in different species and also, I think, a good deal of individual variation. This will be seen in the table on page 115.

In the molting of the wings, the feathers are shed one or two at a time, and symmetrically from the two wings. The first of the quill feathers to molt are the two innermost primaries which are probably shed at almost the same time, as they are at nearly all stages of about the same size (Pl. IV, figs. 1, 2 and 3). Following these the primaries are shed at short intervals, one at a time, finishing with the outermost. The only exceptions that I have noticed to this order are in the Belted Kingfisher, *Ceryle alcyon*, and the Snow Bunting, *Plectrophenax nivalis*.

²The Auk, 1894, p. 287.

The Kingfisher is strikingly different from any other bird examined, in that the first wing feather molted is the fourth primary followed successively by the third, second and first (Pl. V, fig. 3). Three specimens taken at Sicamous, British Columbia, July 18, 1892, show precisely the same order of molt and are in almost the same stage. How the molt proceeds after the first primary is shed, I am unable to say, though the fifth is probably the next to be renewed, followed by the others in regular order inward.

One male *Piranga erythromelas* shows the 7th and 8th primaries molted first, followed by the 6th; while the 9th was shed simultaneously with the 5th. This, however, seems to have been an individual exception.

In the Snow Buntings two molting females (Disko, Greenland, Aug. 11th) show that the innermost primary is lost first, followed by the next four almost simultaneously and then the others in rapid succession. The loss of all these feathers occurs so nearly at the same time, that all but two of the old primaries are shed before *any* of the new ones have grown as long as the secondaries (Pl. V, fig. 4).

The first secondary feather to be molted is the outermost, followed by the others in regular order. The secondaries, however, do not begin to molt until the primaries have nearly all been renewed, the first new secondary appearing simultaneously with the 4th or 5th primary—*i. e.* when only three or four of the old primaries remain (Pl. V, fig. 5).

The first tertial generally appears a little before the first secondary.

The primaries and secondaries seem to be the most persistent of the bird's feathers, and when they are shed, there is always, so far as I have been able to ascertain, a complete molt.

The tertials on the other hand are frequently renewed independently of the other wing feathers during the spring, when there is a partial molt in some species.

As regards the molt of the tail, it has generally been stated that the feathers are shed symmetrically and successively a pair at a time while this may be true it is nevertheless a fact that in many, probably most, of our smaller land birds, the molts of the successive pairs occur in such rapid succession that the bird is for a brief time practically tail-less, and the half grown feathers appear to be all of nearly the same size as in the case of the first tail of the nestling, when partly grown. In other words the first pair of new tail-feathers does not reach a functional length before the last pair of old feathers is shed.

In cases where there is an appreciable difference in the time of shedding the different pairs of tail-feathers, it is the general rule that the outermost pair is the last to be shed, and birds are not infrequently found with the new central pair of tail-feathers half-grown, while the old outermost pair is still retained (Pl. V, fig. 2). The swallows are especially good examples of this, as the molt of the tail in this group seems to be very gradual (Pl. IV, fig. 4).

In *Quiscalus* and some other birds the central pair is the last to be molted, all the others having nearly completed their growth before the old middle feathers are shed.

In the Woodpeckers the molt begins with the pair next to the middle³ and extends outward while the central pair is the last to be shed (Pl. V, fig. 1).

In this family the tail has a particular function,—*i. e.* in climbing; hence the slow molt, as the birds would be at a great disadvantage if the whole tail was lost at once. The central pair of feathers are of particular importance, and the old ones are, therefore, retained until the new quills of the next pair have become sufficiently developed to temporarily take their place during their own renewal.

The tail-feathers generally correspond with the primaries and secondaries in the number of molts which they undergo during the year, but in some cases where there is a spring molt of the body feathers, together with the tertials, there is also a complete molt of the tail, while the primaries and secondaries are not renewed. This takes place—in certain individuals at least—in the Sharp-tailed Finch, *Ammodramus caudacutus*.

Another peculiarity of the tail-feathers is their renewal at times other than those of regular molt, when they have been lost through accident. This does not occur in the wing feathers so far as I am aware. Perhaps owing to the fact that the wing feathers are so much more firmly rooted than any of the other feathers, they are rarely if ever lost through accident, and hence the necessity for renewal does not arise; while the tail-feathers on other hand are the most frequently lost of any of the feathers, for, owing to their position, they are often caught and pulled out by beasts or birds of prey.

Having considered the order of the molt in the body-feathers, wing and tail separately, it remains to consider the relative time of molt

³ In one specimen of *Dryobates pubescens* examined, this pair and the next outer pair were shed simultaneously.

in the three. So far as I can judge from the material that I have, the first two or three primaries are generally shed before the feathers of the abdominal tracts are expanded and the outermost primary is lost at about the time that the body-plumage is completely renewed, while the tail in the majority of species is shed just previous to this—*i. e.* when one or two of the old primaries still remain.

A knowledge of these relations is very valuable in determining whether early fall specimens are adults or birds of the year. In the former the outer primary will be found not quite completely grown, or at least with remains of the embryonic sheath at its base, while in the birds of the year no trace of recent growth or immaturity will be found in the wing or tail feathers, except in a few species which molt the remiges and rectrices of the first plumage in the fall.⁴

As regards species in which the molt of the tail occurs gradually the first tail feathers are shed about the same time as the sixth primary, while the last are shed simultaneously with the last or next to last primary.

In the Tyrannidæ, the body feathers begin to molt sometimes before the first flight feather is shed, and in young *Sphyrapicus* much of the first plumage is retained till long after the flight feathers have been renewed.

The following tables show the relative molting of the feathers in some of the specimens examined, and referred to above:—

I. RELATIVE MOLT OF BODY PLUMAGE.

	New Plumage on Breast.	Interscapulum.	Top of Head.	Throat.
<i>Piranga erythromelas</i> , 1,904, W. S.....	just appearing.	just appearing.	half renewed.	just sprouting.
<i>Sturnella magna</i> , 1,191, W. S.....	nearly complete.	complete.	half renewed.	no molt.
<i>Colaptes auratus</i> , 1,532, W. S.....	nearly complete.	sprouting.	just appearing.	just appearing.
<i>Quiscalus quiscula</i> , 154, W. S.....	nearly complete.	just appearing.	no molt.	no molt.
<i>Plectrophenax nivalis</i> , 26,987, A. N. S.....	complete.	half renewed.	just appearing.	just appearing.
<i>Dolichonyx oryzivorus</i> , 32,783, A. M. N. H.....	complete.	complete.	complete.	center of abdo- men not molted.

NUMBER AND TIME OF MOLTS.

When the young bird emerges from the egg, it is enveloped in a more or less complete covering of down; in pitlopedic birds the cover-

⁴ In any case, a specimen showing molt or evidence of recent molt in the body-feathers, while the rectrices and remiges present no signs of molt, may be regarded with certainty as a bird of the year.

II. SHOWING RELATIVE MOLT OF RECTRICES.

Adults in Annual Molt.	Middle Featr.	2	3	4	5	6
<i>Dryobates villosus</i> , 26,644, A. N. S.....	Old.			Old.	Old.	
<i>Dryobates pubescens</i> , 30,750, A. N. S.....	Old.	2.5	2.5	Old.	Old.	.1
<i>Dryobates villosus</i> , 26,646, A. N. S.....	Old.	2.0	2.0	Old.	Old.	F. G.
<i>Colaptes auratus</i> , 26,694, A. N. S.....	Old.	F. G.	F. G.	1.5	1.5	F. G.
<i>Colaptes auratus</i> , 26,693, A. N. S.....		F. G.	F. G.	F. G.	.2	F. G.
<i>Dryobates pubescens</i> , 26,651, A. N. S.....	.5	F. G.	F. G.	F. G.	F. G.	F. G.
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<i>Tachycineta bicolor</i> , 28,595, A. N. S.....	.7	Old.	Old.	Old.	Old.	Old.
<i>Tachycineta bicolor</i> , 1,660, W. S.....	F. G.	.3	1.3	Old.	Old.	Old.
<i>Tachycineta bicolor</i> , 1,921, W. S.....	F. G.	F. G.	F. G.	F. G.	.2	1.0
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<i>Cyanocitta stelleri</i> , 30,923, A. N. S.....	3.2	3.5	Old.	Old.	Old.	Old.
<i>Spizella pusilla</i> , 1,170, W. S.....	.2	.5	.8	1.5	1.7	Old.
<i>Plectrophenax nivalis</i> , 26,987, A. N. S.....	2.0	2.0	2.0	2.0	2.0	2.5
<i>Passerina cyanea</i> , 28,516, A. N. S.....	1.5	1.5	1.5	1.5	1.5	1.7
<i>Myiarchus cinerascens</i> , 29,456, A. N. S.....	F. G.	.3	.5	1.0	1.5	2.2
<i>Lanius ludovicianus</i> , 1,429, W. S.....	F. G.	.5	1.7	1.8	2.2	2.5
<i>Seiurus aurocapillus</i> , 1,138, W. S.....	.1	.1	.1	.1	.2	.5
<i>Icterus galbula</i> , 28,096, A. N. S.....	F. G.	F. G.	F. G.	.1	.2	.6
<i>Melospiza fasciata</i> , 1,667, W. S.....	F. G.	F. G.	F. G.	F. G.	F. G.	.2
<i>Ammodramus caudacutus</i> , 1,153, W. S.....	F. G.	F. G.	F. G.	F. G.	F. G.	.1
<hr/>						
<i>Quiscalus quiscula</i> , 28,117, A. N. S.....	Old.	3.6	2.0	1.5	1.2	1.0

The four divisions represent four styles of molting.

Numerals denote the amount in inches that the new feathers lack of their full growth. "F. G." denotes "Full Grown." Dashes show that the old feather has been shed but the new one has not yet appeared.

III. SHOWING RELATIVE MOLT OF WING FEATHERS.

	Last Primary Shed.	Molt in Secondaries.	Molt in Tertials.	Molt in Greater Covers.	Molt in Lesser Covers.
<i>Molothrus ater</i> , 28,028, A. N. S.*.....	6	none.	none.	complete.	nearly comp.
<i>Agelaius phoeniceus</i> , 1,579, W. S.....	6	none.	none.	complete.	just begun.
<i>Dolichonyx oryzivorus</i> , 28,000, A. N. S.....	5	none.	half grown.	half grown.	none.
<i>Piranga erythromelas</i> , 1,904, W. S.....	5	none.	mid. shed.	none.	just begun.
<i>Colaptes auratus</i> , 1,532, W. S.....	5	first ½ gr.	½ grown.	complete.	complete.
<i>Quiscalus quiscula</i> , 1,900, W. S.*.....	5	first sprouted.	sprouted.	complete.	nearly comp.
<i>Quiscalus quiscula</i> , 1,541, W. S.*.....	4	first ½ gr.	sprouted.	complete.	nearly comp.
<i>Sturnella magna</i> , 1,191, W. S.....	4	none.	inner spr't'd	complete.	nearly comp.
<i>Chaetura pelagica</i> , 1,521, W. S.....	4	½ gr.	sprouted.	partly molted.	partly molted.
<i>Plectrophenax nivalis</i> , 26,987, A. N. S.....	3	none.	complete.	complete.	partly molted.
<i>Dolichonyx oryzivorus</i> , 32,783, A. M. N. H., †	2	1st and 6th.	complete.	complete.	complete.
<i>Melospiza fasciata</i> , 1,667, W. S.....	1	nearly comp.	complete.	complete.	complete.
<i>Tachycineta bicolor</i> , 1,921, W. S.....	1	nearly comp.	complete.	complete.	complete.

* Molt from first plumage. † Spring molt.

All others are adults in annual molt.

ing is complete, while in psilopædic birds it is but very slightly developed. In præcocial species the downy dress is retained for a considerable time before the first feathers appear, but in altricial birds it is soon replaced by what is known as the "first plumage." The remiges and rectrices of the first plumage are usually the same as those of the adult, but the body feathers, while of the ordinary structure, are much more plumulaceous than the covering of the adult.

This first plumage is retained for some time (three or four months) in some species, but in others it is very soon replaced by a more permanent winter plumage in which all the feathers are of the same structure as those of the adult. The entire body plumage is molted at this time as well as most of the wing coverts; but the rectrices, remiges and the primary coverts are, in the great majority of our smaller land birds, retained until the next annual molt.

The species in which *all* the first plumage feathers are molted are the following: *Otocoris alpestris*, *Cardinalis cardinalis*, *Agelaius phœniceus*, *Quiscalus quiscula*, *Molothrus ater*, *Sturnella magna*, *Scolecophagus carolinus*, *Tachycineta bicolor* and all the Woodpeckers. Of *Ceryle*, *Trochilus*, *Chætura* and a few *Oscines* I have been unable to examine sufficient specimens to speak with certainty on this point.

In early spring, probably about the time of revival of sexual activity and immediately preceding the vernal migration, there is in the vast majority of birds a more or less complete molt. Sometimes, as in the case of the Bobolink, the change is absolutely complete, but as a rule the remiges and rectrices are not renewed, while in other species the molt may only amount to the acquisition of a few new feathers on the throat or sides of the head. The tertials are often renewed at this time and seem to correspond more with the body feathers than with those of the wing as regards their molting. It is at this season that many birds acquire marks of maturity which are lacking during the first winter of their life, as for instance, the yellow superciliary and loreal stripes of certain finches, while markings characteristic of the breeding season as opposed to the winter, also appear at the time of spring molt.

In studying the species of our smaller land birds which molt in the spring it will be noticed that of necessity, species which differ radically in their spring and fall plumage, have the most complete spring molt; while, as a rule, in those in which the plumage is nearly the same throughout the year, the spring molt is least marked. The

Savanna Sparrow and Sharp-tailed Finch are interesting exceptions to the latter statement.

The annual molt which occurs at the close of the breeding season, in late summer or early fall, is common to all birds, and is generally coincident with the molt of the first plumage of the young birds of the first broods, varying, however, in this respect in different species. The annual molt is always complete, and when the new feathers are assumed, the plumage is richer in color and fuller than at any other time. In the breeding plumage, the colors may be in stronger contrast, but this is generally due to the wearing away of the blending colors of the tips of the feathers⁵ which necessarily makes the plumage rougher.

CHANGE OF COLOR BY ABRASION.

During the time intervening between two molts, the feathers undergo a certain amount of abrasion. In such birds, specimens taken just before the annual molt, present a very dilapidated appearance, and the abrasion, combined with bleaching, has generally altered the appearance of the plumage very materially from that of the preceding fall.

While this effect of abrasion is seen in the plumage of all birds just before the annual molt, the feathers of some are so constructed as to render possible a complete change in the color of the exposed plumage by abrasion, long before the time when the effects of the general wear and tear above described are apparent. These feathers have their terminal portion differently colored from the basal, so that when the plumage is in its normal "shingled" position, only the terminal part of each feather is exposed, and the general color of the plumage is the same as this portion of the feather. By the loss of this terminal portion, the differently colored base of the feather comes into view and the general color of the plumage is thus completely changed (Pl. IV, fig. 7). This result is attained by general wear and tear and also, doubtless, by the agency of the bird itself in preening its feathers.

The differently colored tips to these feathers wear off very rapidly, and generally disappear entirely before any perceptible wear is noticeable on other parts of the plumage which are uniform in color. This would indicate that the terminal portions of these feathers are more brittle than the basal part, especially as the breadth

⁵ Except when a complete spring molt occurs.

of the terminal portion varies on different feathers, while the abrasion always takes place exactly to the line of demarcation of the colors.

In the body feathers, the terminal part is less perfectly pennaceous in structure than the base, and many of the barbs are entirely free at their tips, which naturally makes them more liable to rapid abrasion down to the point where the strongly pennaceous structure begins.⁶ This is particularly well seen in the Snow Bunting. A



Fig. 1. Tips of several barbs from feather of Snow Bunting showing the difference in structure between the light and dark portions (greatly enlarged) Photograph by Dr. A. P. Brown.

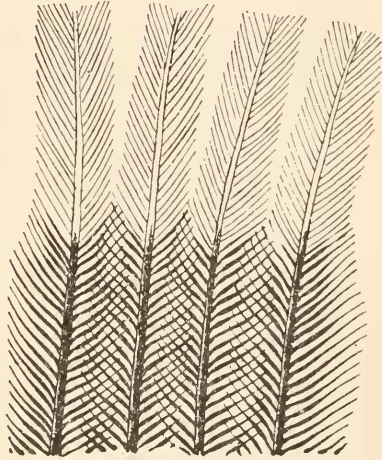


Fig. 2. Same, further enlarged, with the barbs undisturbed showing the interlocking of the barbules in the black area. Somewhat diagrammatic, after photograph by Dr. Brown.

microscopical examination of these feathers, conducted at my request by my friend Dr. A. P. Brown, shows further that the hooklets on these terminal parts are fewer in number and less perfectly developed, while the basal portion of the feather where the dark pigment begins is thicker and probably tougher in structure, the barbules and hooklets being here well developed (Fig. 1 and 2).

⁶ A paper by Mr. Frank M. Chapman has appeared since the above was written "On the Changes of Plumage in the Snowflake, *Plectrophenax nivalis*," Bull. Amer. Mus. Nat. Hist, VIII, pp 9-12. In this he reaches exactly the same conclusions as are here set forth by the writer and Dr. Brown, and the fact that we were working entirely independently gives additional interest to the statements.

Certain wing feathers show a still more interesting phase of abrasion. In the Rose-breasted Grosbeak, as is well known, secondaries and tertials in autumn and winter are marked on their edges with spots of white (Plate V, figs. 7, 8), while in the Meadow Lark and Curlews at the same season, many of the feathers have regular tooth-like indentations of lighter color along the sides (Plate IV, figs. 8, 9). By the time the breeding season has arrived these light-colored areas have been completely lost, while the dark parts remain intact, the line of demarcation having been followed as closely as if cut by a pair of scissors, except that some curved lines become straight owing to the whole barb breaking off beyond the light colored area (Plate IV, fig. 9). In these feathers, both portions are equally pennaceous, and do not exhibit any difference in structure, so that we must regard the light portions as peculiarly brittle. It is a noticeable fact that in all the birds that have been examined, the black feathers or black parts of a feather seem less subject to abrasion than those of any other color.

In most cases where marked abrasion takes place, the lighter tips serve to produce the blended appearance characteristic of the winter plumage of all birds, while their loss brings out the strong contrast of colors characteristic of the breeding season, and produced in other species by actual molt.

The case of the Bobolink is of particular interest in this connection, differing from that of any other species, unless it be some individuals of the Rose-breasted Grosbeak. It has a complete spring molt, but instead of assuming the breeding plumage at this time, as in the case of most birds which molt in the spring, it assumes a dress almost as dull and blended as its winter attire, but which is transformed to the breeding plumage by the abrasion of the long buff tips which adorn all the feathers.⁷

The utility of such a process is difficult to see. The long tips are "acquired to be lost" as it were; they begin to break off immediately and within two months have disappeared.

SEASONAL PLUMAGES.

The number of recognizable plumages, which a bird may assume, is obviously dependent upon the length of time that is required for it to acquire the mature dress. The simplest case is where this is accomplished when the first-plumage is molted or at the end of the

⁷ See Chapman, *Auk*, 1890, p. 120.

summer in which the bird is hatched. In such a species then, there are only three plumages: 1. First Plumage. 2. Winter Plumage. 3. Nuptial Plumage;—the latter being acquired in early spring, either by actual molt or abrasion. Sometimes it is so like the winter plumage that they can scarcely be distinguished, but this is the exception, for even when no molt takes place, the abrasion gives such a different appearance to the plumage by wearing off the blending shades that the spring and fall birds can easily be separated.

In other species the winter plumage of the young bird is not absolutely like that of the adult, every shade of difference existing from those that are scarcely separable to those that are radically different.

In such cases there are, of course, four or five recognizable plumages: 1. First Plumage. 2. Plumage of First Winter. 3. Plumage of First Nuptial season. 4. Adult Winter Plumage. 5. Adult Nuptial Plumage. In most species the Adult Nuptial Plumage is assumed at the first spring molt, in which case there will be only four distinct plumages. Sometimes the number of plumages is still further increased by the fact that the bird does not acquire the complete adult dress for three or four years. The changes, however, do not progress as regularly in these instances after the first year, a greater or less amount of the adult plumage being assumed at each molt by different individuals; so that a large series instead of being divisible into several lots, each characterized by distinctive marks, represents on the contrary a complete gradation from the bird of the year to the adult. Such instances have been made to serve as examples of the alleged change of plumage by direct change in the coloration of the feathers.

Another point bearing upon the plumages of species that require several years to acquire the mature dress, is the question whether there are not some individuals which never do acquire this plumage. The fact of the remarkably small proportion of birds in fully adult plumage in such species as the Purple Finch, Pine Grosbeak, White-throated Sparrow, etc., lends weight to such a theory, although its actual demonstration is, perhaps, impossible.

Then again, there are occasional peculiar plumages, which, though they may be abnormal, are nevertheless by no means unique, such as the bright orange plumage of the male Scarlet Tanager, the Black-headed plumage of the female Rose-breasted Grosbeak, and

the occasional extremely brilliant plumage of the male of the same species, etc. The two latter instances may be considered as: 1. Partial adoption of the characters of male plumage by the female; and 2. Extreme development of color in the male probably due to excessive vitality.

Another complicated series of plumages pointed out by Mr. F. M. Chapman⁸ exists in the case of the Bobolink. In these birds there are four distinct plumages: 1. First Plumage. 2. Winter Plumage. 3. Early Spring Plumage. 4. Nuptial Plumage.⁹ This early spring plumage is acquired by direct molt, and passes into the Nuptial Plumage by an extensive abrasion of the differently colored tips.

DIRECT CHANGE OF COLOR IN FEATHERS.

There have always been, and are to-day, ornithologists who believe thoroughly that feathers actually change their color, and that the change from the winter plumage to the nuptial dress in some species is accomplished solely in this manner without either molt or abrasion.

Schlegel, one of the greatest exponents of this theory, considered the phenomenon as nearly universal, and Gätke, another of its staunch supporters, seems to be of much the same mind. Other writers while supporting it, have regarded it as of much less general application and some consider it of very rare occurrence.

If such a change actually does take place, it would seem strange if it should not play a very important part in plumage-changes, and, if we admit that it does occur in any species, we may as well grant its possibility in a great number.

The importance of the question warrants a very careful consideration, and, in order not to be misunderstood, I may state at the outset that in spite of the instances that have been cited to illustrate this phenomenon, I have not yet found a single case that cannot be otherwise accounted for, and, cannot, therefore, admit that we have any proof of an actual change of color in a feather apart from what may be produced from abrasion or bleaching.

In most instances which have been cited in support of this theory, the writers have, it seems to me, fallen into the same error—*i. e.*, they have taken a series of specimens, showing all sorts of mottled intergrades from one plumage to another, as indicating that each

⁸ Auk, 1890, p. 120.

⁹ If we consider the birds of the year as recognizably distinct from the fall adults we must regard "2" as First Winter Plumage and add "5". Adult Winter Plumage.

individual bird passed through all those gradations; or they have taken a series of feathers from different individuals or different parts of the same individual, which show regular gradations from one style of coloration to another, as proof that each feather passes through all those gradations.

As a matter of fact, these mottled plumages are permanent for the time being, and at each regular molt a greater proportion of the adult plumage is assumed. Scarcely any two individuals, however, correspond exactly in the amount of change that is effected at a given molt;¹⁰ hence a series of breeding birds taken during the late spring or early summer, representing individuals of different age, will often show a nearly complete series of intergrades between the two styles of plumage, and there will, of course, be no signs of a molt.

A study of several of the more recent examples that have been brought forward to illustrate the actual change of color in feathers, will be of interest in this connection.

Dr. R. Bowdler Sharpe, in the Catalogue of Birds in the British Museum, seems to regard this alleged phenomenon as of rather common occurrence, and in some instances goes into much detail with regard to the subject. This is especially the case in treating of *Motacilla lugens*,¹¹ in which he claims, not only a change from gray to black in the plumage of the back, but also a remarkable change in the color of the primaries and secondaries from brownish to pure white, the adult plumage being assumed according to Dr. Sharpe's theory, in the first spring.

With the same material examined by Dr. Sharpe, and a little more showing the molt in progress, Dr. Stejneger¹² shows conclusively that this species requires several years to acquire the fully adult plumage, and that the changes in the color of the wing feathers is effected by actual molt and not by a change in the color of each individual feather. This shows conclusively the importance of having specimens in the molt for examination and comparison, and what a different aspect they may put upon the case.

While combating the theory of direct color change in *Motacilla*

¹⁰ It is not intended that only a part of the plumage is changed; while this may be true of the spring molt, the annual molt is always characterized by a complete change, but, in the cases referred to, part of the new plumage comes in exactly like the old, while in other parts the color of the new plumage is different.

¹¹ Cat. Bds. Brit. Mus., X, 1885, p. 474.

¹² Proc. U. S. Nat. Mus., 1892, p. 307.

lugens, Dr. Stejneger, nevertheless admits it in the case of *Zanthopygia narcissina*,¹³ on what seems to me insufficient evidence.

This bird he believes changes without molt from an olive plumage to one of brilliant orange-yellow and black, while the wings and tail change from a dull brownish-gray to a deep black. I have examined the series which Dr. Stejneger had in hand, and I fail to see anything in that cannot be found in a similar series of *Icterus spurius* or any other species that acquires its mature plumage by successive molts, the mottled plumage being permanent for the time. So far as I can see, an actual molt of black and yellow feathers might occur in early spring, or patches of them might be acquired at the annual molt at the end of summer. As there are no specimens in Dr. Stejneger's series taken earlier than the 29th of April, and no fall adults, it is hardly justifiable to conclude that the change in color does not take place by a direct molt, either in early spring or in late summer.

Furthermore, a specimen of the closely allied *Z. tricolor*,¹⁴ which agrees very well with Dr. Stejneger's most advanced "transition" specimens, having a few patches of olive-brown feathers above and brown remiges, but otherwise adult, shows by the presence of numerous "pin feathers" that the yellow breast, and the black on the head have just been assumed by direct molt.

That this specimen is an early spring bird I assume from the fact that the remiges and rectrices show no signs of recent molt, which they would do if it was the annual molt that had just occurred.

In regard to the remiges and rectrices of *Zanthopygia*, which Dr. Stejneger thinks change suddenly from dull brown to deep black, precisely parallel cases are to be found in *Piranga erythromelas* and *Habia ludoviciana*, and a series of either collected in May or June will show just the same variety of color in the quills as in the case of *Zanthopygia*.

In these species the dull colored quills are retained during the first spring when the winter body plumage is molted for the adult dress, but at the annual molt the jet black quills are assumed and there is certainly no direct change in the color of the feathers.

Gätke in his "Heligoland," gives us the most recent endorsement of the theory of actual color-change, a theory of which he was always a strong advocate. The instances which he treats in detail are

¹³ Proc. U. S. Nat. Mus., 1892, p. 334.

¹⁴ 791, Coll. Acad. Nat. Sci. Phila.

almost entirely from the water birds, and we are not informed of the exact character of the material which came under his observation, all that we have is his interpretation of the facts. The species to which he calls especial attention are the Dunlin, Knot and Sanderling.

“In the Dunlin” he says “the change of colour develops itself in the following manner: In the ash-grey feathers of the back the shaft first becomes black; this color spreads rapidly over the feathers, finally leaving only broad gray margins. The latter at first change to a dull rusty-grey, which, however, subsequently passes into a beautiful ferruginous color. At the same time the dull ash-grey tips of the feathers pass into a whitish-grey, their margins being simultaneously rounded off to their former entirety.”

How such a theory could have been advocated, after the examination of a large series of specimens, I cannot understand, for a series of spring examples of the American Dunlin taken on the coast of New Jersey show the black and rusty feathers coming in abundantly and supplanting the worn gray feathers of the winter plumage.¹⁵

In the Sanderling Gätke states there is a change from a uniform light gray to a deep black, and from a beautiful ferruginous color to a pure white. Here again spring specimens, from the coast of New Jersey and Florida, show the black and ferruginous plumage molting in and superceding the light gray plumage of winter.

Gätke says (p. 163) that he “confines his description to what actually takes place, without embarking on any hypothetical conjectures.” In this, however, I cannot agree with him; he does not claim to have seen the change in color actually take place in any individual feather, and to make the assertion that feathers change from one style of coloration to another when the only facts before him are that he has feathers which represent those styles of coloration, one of which might change to the other, involves entirely too great an assumption.

In his chapter on “colour-change without moulting” Gätke supports another theory, also originally advanced by Schlegel, but which

¹⁵ Since the present paper was presented to the Academy for publication (see Proc. Acad. Nat. Sci. Phila., 1896, p. 12), Mr. F. M. Chapman has published an article on “The Changes of Plumage in the Dunlin and Sanderling” (Bull. Amer. Mus. Nat. Hist., VIII, p. 1-8), in which he criticises Gätke's statements on the same grounds as above. Here again, it is interesting to note that Mr. Chapman and the writer working independently, arrived at exactly the same conclusions.

Gätke formerly repudiated, and one which other advocates of the "color-change" theory have generally left untouched, *i. e.*, the theory that simultaneously with the change in color there occurs a rebuilding of the worn edges of the feathers which restores all the even contours and gives them the appearance of newly molted feathers.

The acceptance of the theory of color-change without molt or abrasion, necessitates the adoption of some such theory as this, since the bright spring feathers are generally much more perfect in outline and often in striking contrast to the worn winter plumage from which Schlegel and Gätke would have us believe they have been produced. A slight knowledge of the development of feathers would tend to show the absurdity of such a theory as this, since the barbs of a feather do not continue to grow out from the shaft like the limbs of a tree, but are really formed from the tip inward toward the shaft. And once being unfolded from the sheath of the "pin feather," no further structural development can possibly take place in them.

Too many writers have made arbitrary statements and then questioned the accuracy of the investigations of histologists because they did not support them. In investigating these questions, we must accept at the outset the testimony of physiologists and histologists, that from the very nature of the structure of a feather it is incapable of renewing its barbs or barbules, and that after the contents of the quill have once dried up there is no connection between the vanes of the feather and the life fluids of the bird. This at once precludes the change of pigment, except by chemical action from without, and it is difficult to see how this should only exert an influence during a certain short period and have no effect at other times.

It has been suggested that the presence of innumerable bubbles of air would tend to obscure the pigment in a feather and cause it to appear white, while the expulsion of air from a white feather might bring out a dark pigment previously concealed. In the case of the *Motacilla*, however, portions of the plumage turn white and other parts black at the same time and it is hard to understand how an external action could affect different feathers in an exactly opposite manner, and if there was proved to be exhalation from the body into the feather, the structure of the feather would preclude a passage of air into the barbs from the quill. It might further be added, that the yellow feathers of *Zanthopygia*, which should according to this theory contain a concealed dark pigment, have really no

pigment at all, as has been ascertained by careful microscopical examination by my friend Dr. Thos. H. Montgomery.

The only instance where I know of an actual change of color in the plumage, except by fading, is in the case of certain delicate pink tints on the breasts of gulls, which disappear after death, but this color, I think, is probably due to a peculiar surface structure which is destroyed or altered by the drying out of the plumage, when removed from contact with water or the oil of the bird.

PLUMAGES AND MOLTS OF THE SMALLER LAND BIRDS OF EASTERN NORTH AMERICA.

Below I have recorded such facts as I have been able to gather regarding the molts and plumages of our smaller land birds.

In a number of species I have been unable to ascertain the exact extent of the molts or their number from lack of necessary material, but have thought it best to give such facts as I have rather than to omit the species altogether. Some species on the other hand I have been able to treat with much detail, and have referred to them in describing others with a similar series of molts. I have as a rule omitted any detailed description of the plumages, as these can be obtained from any of the manuals or general works on North American birds, and have made my remarks as to colors, etc., mainly comparative.

Where I had sufficient material to warrant it, I have given after each species a list of its plumages, considering three as the smallest number of plumages exhibited by any species. In many, however, the winter and nuptial dresses are practically alike except for a slight abrasion.

Where male and female are not definitely indicated their molting is the same.

Family CUCULIDÆ.

Coccyzus erythrophthalmus (Wilson). Black-billed Cuckoo.

Coccyzus americanus (Linn.). Yellow-billed Cuckoo.

I have been unable to examine any adult Cuckoos in the molt. The young molt the body plumage the last week in August. I am inclined to think that there is no spring molt in either species. Spring and fall specimens it is true are scarcely distinguishable, but I do not consider the unworn appearance of spring birds as a necessary proof that there has been a spring molt, as an examination of

late summer specimens, just previous to the annual molt, shows that abrasion produces scarcely any effect in the Cuckoos. The sexes are alike in molts and practically so in plumages.

Family **ALCEDINIDÆ.**

Ceryle alcyon (Linn.). Belted Kingfisher.

The Kingfisher presents several peculiarities in its molting and I have not yet been enabled to examine sufficient material to satisfactorily describe it. So far as my material goes I think the rufous edgings to the breast band belong only to the bird of the year, as old birds in the annual molt have the new feathers of the breast band plain bluish slate or slightly edged with white. Whether the young molt the flight feathers with the rest of their first plumage I cannot say, but the wing feathers of the rufous tipped fall birds are very fresh and perfect, which may be considered evidence that they do.

That there is a partial molt in early spring is evidenced by the fresh feathers in spring specimens which are in strong contrast to the older worn plumage, especially on the pectoral band.

The wing feathers of some spring birds are unusually bright with the white tips scarcely worn and one example, (June, 1881, Palo Alto Co., Iowa, No. 26,640, A. N. S.), has the remiges all of this character, except the innermost pair of primaries and one of the secondaries on the left side, which are very much worn and abraded. This may indicate a spring molt of the wings in some individuals but in the majority it apparently does not occur. The peculiar order of molt in the primaries has already been noticed.

Family **PICIDÆ.**

The North American Woodpeckers,¹⁶ as already pointed out by Mr. Brewster, (Bull. Nutt. Orn. Club, 1878, p. 179), always molt the wing and tail feathers along with the rest of the first plumage. The molt of this plumage, especially on the head and breast, goes on slowly and the birds start on their southward migration before it has been entirely renewed. In some individuals indeed the molting is not completed till well into the winter.

Dryobates villosus (Linn.). Hairy Woodpecker.

Male.—Three plumages, first, winter and nuptial.

All plumages of this bird are very similar. There is no spring molt apparent in any specimens examined and but little effect is

¹⁶ And probably all of the family.

produced by abrasion. *Female* molts exactly as in the male, but its plumage lacks the red nuchal band.

Dryobates pubescens (Linn.). Downy Woodpecker.

Molts and plumages as in the last. Some spring specimens show a renewal of some of the breast feathers, but this may also take place in *villosus*. A fall specimen of each species exhibits a remarkably worn "moth-eaten" appearance on the breast and flanks probably due to a peculiarity in the habits of these individuals.

Sphyrapicus varius (Linn.). Yellow-bellied Sapsucker.

Male.—Three plumages, first, winter and nuptial.

The molt of the first plumage of the head and breast of this species continues all through the fall and winter and one taken April 8th, (Philadelphia, Pa.), shows a few new feathers appearing on the crown and throat. The winter plumage is, therefore, a mottled one. The breeding bird is hardly different from the full plumaged spring individual, as abrasion produces but little effect. *Female* molts like the male. Adult plumage differs in having the throat white, some individuals have the crown black, others red; whether this is due to age or purely individuality I cannot determine.

Geophlœus pileatus (Linn.). Pileated Woodpecker.

Three plumages, first, winter and nuptial.

This species shows but little variation in plumage. There is no spring molt, but the nuptial dress is somewhat abraded and browner than the winter plumage.

Melanerpes erythrocephalus (Linn.). Red-headed Woodpecker.

Three plumages, first, winter and nuptial.

The first plumage is retained for a long time; of four specimens showing the transition to the adult, only one has data, *i. e.*, Haddonfield, N. J., Dec. 2, 1880, No. 1,405 Coll. W. Stone. This I think is probably the regular time for the molt, as specimens taken in October show no signs of a change. The annual molt of the adult occurs during the middle of August as usual. Whether they have any spring molt I am unable to say positively. The plumage is but little affected by abrasion, so that the unworn appearance of spring birds is not necessarily an evidence of a recent molt. Very highly colored individuals have a red patch on the center of the abdomen.

Melanerpes carolinus (Linn.). Red-bellied Woodpecker.

Without a satisfactory series I am unable to describe the molt of this bird in detail, but it is apparently the same as in the preceding species.

Colaptes auratus (Linn.). Flicker.

Three plumages, first, winter and nuptial.

The molt from first plumage begins in July, a specimen taken August 9, 1893, in Montgomery Co., Pa. shows it about half completed. The annual molt of the old birds occurs at the same time. I can find no trace of spring molt and abrasion produces little effect upon the plumage until after May. Mr. F. M. Chapman has described in detail the variation in the upper tail coverts in this genus.¹⁷

Unfortunately I have been unable to examine a sufficient series of the *Macrochires* to give a complete account of the molting of any of the species, but have included such notes as I have.

Family CAPRIMULGIDÆ.

Antrostomus vociferus (Wils.). Whip-poor-will.

As shown in Wilson's figure this bird has an early downy plumage which almost immediately gives place to the usual "first" plumage, a specimen taken at Haddonfield, N. J., July 2, 1893, (Coll. W. Stone), shows the transition. As regards the number and time of molts, a comparison of specimens would indicate that they are the same as the following.

Chordeiles virginianus (Gmel.). Night Hawk.

Mr. Wm. Brewster has described transition specimens from the early downy plumage to the first plumage and similar ones are in the collection of the Academy of Natural Sciences of Philadelphia from Florida. A specimen taken Sept. 10, is in the first plumage, with many new feathers appearing on the breast and elsewhere, but no molt of the flight feathers; how complete this molt is I cannot not say. An adult specimen taken Sept. 1, shows much renewal of the body plumage, but no trace of it in the wings or tail. It would seem from this that the molt was quite late, and the loss of the flight feathers relatively later than in most birds. I have seen no trace of spring molt.

Family MICROPODIDÆ.

Chætura pelagica (Linn.). Chimney Swift.

Plumages, first, winter, nuptial.

The annual molt in this species occurs from Aug. 1 to the first week of September and there seems to be no spring molt. Abrasion

¹⁷ Bull. Amer. Mus. Nat. Hist., Vol. III, p. 311.

does not produce much effect upon the plumage but it loses the bright metallic luster which characterizes the fresh winter dress. I am inclined to think that the young do not renew the flight feathers at their first molt.

Family TROCHILIDÆ.

Trochilus colubris (Linn.). Ruby-throated Humming-bird.

The only molting specimens of the Humming-bird that I have seen are spring birds taken at Labna, Yucatan, March 15th, in which the feathers on the throat are being renewed. Probably, the young males acquire the ruby throat at this time.

Family TYRANNIDÆ.

The Tyrant Flycatchers show scarcely any seasonal variation, the first plumage being nearly the same as the adult, while the feathers are very little affected by abrasion. There are, therefore, as a rule only three plumages; first, winter and nuptial.

Tyrannus tyrannus (Linn.). Kingbird.

Adult Kingbirds, taken August 21, show some molt on the body but no trace of renewal of the flight feathers, which would indicate that the annual molt is not completed until quite late. Some spring specimens show a few new feathers appearing on the breast and back, but whether there is a more extensive renewal of the plumage before the birds start north from their winter quarters I cannot say. Abrasion plays little or no part in changing the plumage of this species. The first plumage gives way to that of the adult late in August but no molt occurs in the wing and tail.

Myiarchus crinitus (Linn.). Crested Flycatcher.

The annual molt in this species begins early in August and is indicated in the wings before any new feathers appear on the body, differing in this respect from the last. There seems to be no spring molt. The young birds of the first brood begin to renew their body plumage early in August. All the plumages of this bird are very similar.

Sayornis phœbe (Lath.). Pewee.

There is no spring molt in the Pewee but much abrasion takes place during winter so that the sulphur tint of the under surface, which is characteristic of fall specimens, is nearly lost by the breeding season. The molt of first plumage in the young is restricted to the body feathers.

Contopus virens (Linn.). Wood Pewee.

I am unable to say, from an examination of spring specimens, how much of a molt this species undergoes before its northward migration. Compared with specimens of the preceding they appear much less abraded, which indicates that a partial spring molt occurs.

Contopus borealis (Swains.). Olive-sided Flycatcher.

The above remarks apply equally well to this species.

Empidonax.

The species of this genus all resemble *Contopus* in the appearance of their seasonal plumages. The freshness of the spring feathers seems to indicate a partial spring molt at least, but without a satisfactory series of winter specimens; it is not possible to decide this point. The renewal of the body plumage at the annual molt, as in *Tyrannus*, begins before there is any molt of the flight feathers.

Family ALAUDIDÆ.

Otocoris alpestris (Linn.). Horned Lark.

Plumages, first, winter, nuptial.

There seems to be no spring molt in this species, but a great deal of abrasion takes place during winter and spring, by which the light edgings to the black crown and throat patch are lost and the other colors brought into stronger contrast. The young birds molt the flight feathers at the end of summer along with the rest of the first plumage.

Family CORVIDÆ.

Cyanocitta cristata (Linn.). Blue Jay.

Plumages, three; first, winter and nuptial, though, except for the slight effects of abrasion, there is no difference between the last two.

There is no spring molt and the young molt only the body plumage at the end of their first summer.

Perisoreus canadensis (Linn.). Canada Jay.

Three plumages, first, winter and nuptial.

I have not been able to examine a satisfactory series of this species but feel pretty sure that its molt is the same as in the preceding.

Corvus corax principalis Ridgw. Raven.

I have been unable to prove the number of molts in the raven by actual examination of molting specimens, but such material as I have before me indicates a precisely similar molt to that of the crow.

A molting specimen from Sitka, Alaska, June 15, 1895, shows that the central tail feathers are the first to be renewed, and are well grown before any of the others are dropped.

Corvus ossifragus (Wils.). Fish Crow.

Corvus americanus (Aud.). American Crow.

Three plumages, first, winter, nuptial.

The Crow has no spring molt so far as I can ascertain; the annual molt is quite early, occurring in June or July, while the young birds molt the first body plumage about the end of the latter month. As in most black birds abrasion is but little marked. Many specimens, however, are dingy and have the tips of the wings bleached to a brown tint. The Fish Crow apparently molts exactly the same.

Family ICTERIDÆ.

The Icteridæ may be arranged in three groups as regards their molt.

Dolichonyx has two complete molts each year standing alone among our smaller land birds in this respect. The young probably has no molt of flight feathers at the close of its first summer. The two species of *Icterus* have a more or less complete spring molt of the body feathers the first year at least, and the young do not molt the flight feathers in August. The rest of our species have no spring molt whatever, but the young have a complete molt at the end of the first summer, including both wing and tail. This occurs in only three other instances among our Passeres—*i. e.*, in *Cardinalis*, *Tachycineta* and *Otocoris*.

Dolichonyx oryzivorus (Linn.). Bobolink.

Male.—Plumages, first, winter, early spring, nuptial.

The molting of this species has been so carefully treated by Mr. F. M. Chapman who was the first to describe the early spring plumage and the manner in which it is acquired, that it is hardly necessary to go into details in this connection. When the young bird has acquired the buff winter plumage it is practically undistinguishable from the winter adult.

Early in spring (March 1st,) this plumage is entirely molted even to the wings and tail and a new black plumage is assumed, all the feathers of which are so broadly edged with brownish buff that the general plumage appears to be of this shade. By the breeding season the aspect of the plumage is again changed, this time entirely by abrasion, and the bird appears in its black and white dress.

The Bobolink furnishes the only instance known to me, among the species here treated, of a molt of the remiges in the spring. The molt of the Rose-breasted Grosbeak, with this exception, is almost parallel for the first season, though the buff edgings which are lost by abrasion are not quite so much developed. Afterward, however, the Rose-breast has a winter plumage quite different from that of the first year while the Bobolink, year after year, returns to the buff "Reed-bird" garb. The old winter birds are perhaps of a little different shade of buff and I think it is only the old birds that show the occasional black feathers in fall.

Mr. Chapman's specimen in the spring molt as well as specimens in the annual molt have been examined. I have been unable, however, to ascertain whether the young bird molts the wing and tail feathers with the rest of the first plumage or not.

Female.—Plumage always similar to winter dress of male. I have not been able to ascertain whether there is any spring molt or not, the breeding plumage, however, is much lighter than the winter dress owing to abrasion. A curious plumage is shown in a specimen from Raleigh, N. C. May 2, 1893, No. 86, Coll. W. A. Shryock, in which there are many black feathers on the breast, belly and head, evidently an approach to the male pattern of coloration.

Molothrus ater (Bodd.). Cowbird.

Male.—Plumages; first, winter and nuptial; the last two, however, are scarcely distinguishable, owing to the very small effect produced by abrasion in this species.

There seems to be no spring molt whatever, and almost the only effect of the abrasion is to emphasize the line of demarcation between the brown head and the black back. The young molt the wing and tail at the end of summer with the rest of the plumage.

Female.—Molts as in the male. The adult plumage is entirely gray and the abrasion is very marked in spring, presenting a "clipped" appearance exactly as in *Ammodramus maritimus*.

There is no change in the coloration of either sex of the Cowbird after the first winter dress has been assumed.

Agelaius phœniceus (Linn.). Red-winged Blackbird.

Male.—Five fairly marked plumages may be distinguished:—first, first winter, first nuptial, adult winter and adult nuptial, the last two, however, as in many other species, differ very slightly.

At the end of the first summer the entire plumage of the young bird is shed, including the wing and tail, and a black dress broadly edged with brown is then assumed.¹⁸ This becomes almost entirely black by the breeding season through abrasion. Owing to the extent of the abrasion, however, the plumage presents a somewhat worn appearance and there is always more or less trace of the brown edgings present. The subsequent winter plumages show much less of the brown borders and eventually this dress is nearly pure black; except, of course, the shoulders. This is well shown in a fall male of *A. phœniceus sonoriensis* in the U. S. Nat. Mus. Coll. Whether the brown edges are ever entirely lost at the second annual molt or whether birds in such plumage are always several years of age I cannot say, but incline to latter view. The less brown margins to the winter plumage, the less abrasion takes place and the nuptial plumage appears relatively smoother. The depth of color of the red shoulder patch is not necessarily an index of the age, as some birds in the first year have deep red shoulders.

Mr. Brewster describes (*l. c.*) an occasional, though not unique plumage, which has a "crescentic patch of pale yellow tinged with rose-color upon the breast," which he regards as an "exceedingly high phase of ornamentation."

Females.—Vary considerably in the tints on the throat; the buffest ones I take to be birds in their first year and those with the pinkest throats are probably the oldest. The red on the shoulder of the females increases in proportion to that on the throat. The molts are exactly the same as in the male, and the abrasion in spring always well marked.

Sturnella magna (Linn.). Meadow Lark.

Male.—Plumages, first, winter and nuptial.

The Meadow Lark, as in the preceding species, molts both wing and tail at the end of the first summer. There is no spring molt, the change to the breeding dress being produced entirely by abrasion. All the under surface is veiled in winter with long brownish or buff tips. The bright yellow and black tips are only brought out when these are lost. On the upper surface the abrasion affects the light margins to the body feathers and the light bands and indentations on the tertials, which become worn in a most remarkable manner (see Plate IV, figs. 8 and 9). There is some variation in the extent

¹⁸First described by Mr. Wm. Brewster, Bull. Nutt. Orn. Club, 1878, p. 175.

of the brown margins of the winter plumage, birds showing the least being probably the oldest.

Female.—Like the male in molts and plumages.

Icterus galbula (Linn.). Baltimore Oriole.

The males of this species assume four distinct plumages. The first plumage is ashy on the back passing into dull orange on head and rump and whitish below, wings suffused with yellow-brown bordered with white and tail dull orange. The body feathers of this dress are soon shed and the plumage of the first winter assumed, generally by the middle of August. In this the back is dull orange, brightest on the head and rump and mottled with dark-brown on the interscapulum; below nearly uniform bright orange-yellow. These two plumages are remarkably similar, the latter being uniformly brighter and richer and easily distinguished by the different structure of the feathers.

In early spring there is a molt which as usual varies exceedingly in its extent in different individuals. Usually the entire black body plumage of the adult is assumed covering the back, entire head and throat, also the reddish-orange on the breast, sides of the abdomen and a certain amount on the rump. The middle of the abdomen and the greater part of the rump, however, retain the old yellowish winter plumage. There is great irregularity in the molt of the tail as well as the tertials and greater wing coverts. All but one of the specimens examined show some molt in these feathers, but in none is it complete.

One has renewed all the tail but the four outer feathers of the left side, another has renewed only the middle pair and one other; and still another retains three old feathers on the right side. The specimen which shows the least molt in the first spring (No. 25,734, Coll. A. N. S. May 24, 1864, Republican Riv., Kas.), has only acquired part of the black head, the old yellow plumage remaining in a large nuchal patch, while below the reddish-orange feathers have appeared only on the breast. There has been no molt, whatever, in the wing or tail.

The black interscapular plumage, which is assumed by the Baltimore Oriole at the first spring molt, shows the same variation as exhibited in the Rose-breasted Grosbeak, *i. e.*, in some individuals the feathers are uniform black while in others they are bordered with orange. At the annual molt in July the entire plumage is renewed and the perfect plumage is acquired. This is like the

previous dress, but the whole abdomen and rump and lesser wing coverts are bright reddish-orange, while the black is more intense. All the other wing feathers are jet black bordered with white; the two middle rectrices are black, the next pair largely black, the others orange with more or less black on the base. The interscapular feathers are generally slightly tipped with orange.

In the second spring there is no molt, unless there may be a renewal of some of the scattered feathers but the light tips of the interscapular feathers are entirely lost from abrasion and the white on the wings is greatly reduced and on the tertials entirely lost from the same cause.

Icterus spurius (Linn.). Orchard Oriole.

Notwithstanding the large amount of material that I have examined, I have been unable to procure specimens which show conclusively the history of the molts of this bird. The large series, aggregating several hundred skins, contained in the collections of the Academy of Natural Sciences of Philadelphia, National Museum, American Museum of Natural History and the private collection of Mr. William Brewster, contains all together only four specimens in the molt, of which but two bear the date of capture. In view of this scarcity of molting birds, we are compelled to judge of the molts mainly from comparing specimens taken before and after the plumage has been renewed.

Male.—The young birds change the first plumage for that of the first winter in July or August. This dress is as a rule scarcely different from the first plumage. Some few individuals, however, show a few black feathers on the throat. In February or March there is a molt of the feathers of the head and throat, and all the males that reach us from the south in the spring have a black throat, the extent and purity of the black varying in different individuals. I have no green males in the annual molt nor after the molt is completed. One specimen (No. 91,034, U.S. Nat. Mus. Coll.), taken in Nicaragua, Feb. 23, 1883, shows the throat and head to be molting. That this bird is not in its first spring molt is shown by the fact that some old throat feathers which have not yet been shed are black. The plumage of the second spring is similar to that of the first, but the black throat is more complete and there are traces of chestnut on the breast. The tail is also clouded with black, but as the specimen just referred to is not molting the tail, I think that this change is effected at the preceding annual molt. It is probably at the next annual molt that

the chestnut and black plumage is acquired. It is impossible to tell from an examination of spring males in the green plumage, how many years they remain in this dress, as the individual variation in the amount of change effected at a given molt is so great, that there is a complete series of intergrades from one extreme to the other. Between the most advanced specimen and the adult chestnut plumage, however, there is quite a gap, and I have never seen any specimens like those figured by Wilson and Audubon.

The variation in the marking of spring birds is shown by the following table :

Males, 1st. and 2nd. Years.	Tail green.	Tail partly black.	Trace of chestnut on rump.	Trace of black on head.
Throat-patch incomplete (4).....	4	0	1	0
Throat-patch complete, little or no chestnut (14).....	13	1	1	4
Considerable chestnut on breast (12).	5	7	12	12

The spring molt is generally confined to the head and throat but in some second year birds it is more extensive and in one, (122,073, U. S. Nat. Mus. Washington, D. C., May 2, 1887), the body molt must have been nearly complete, while the tertials and indeed the wing feathers show scarcely a trace of abrasion. Old chestnut colored birds have the plumage, especially above, edged with buff, which is lost by abrasion before the breeding season.

Female.—Remains as the male in first winter. Spring specimens differ in showing much abrasion but there is little if any spring molt.

Scolecophagus carolinus (Müll.). Rusty Blackbird.

Male.—Plumages, first, winter and nuptial.

Only one molt a year, the change from winter to nuptial dress is effected entirely through abrasion.

Female.—Molts as in the male. Adult plumage always gray instead of black. I have seen no molting birds of either sex, but Dr. J. A. Allen writes me that the young renew the flight feathers at their first molt, as in the allied genera.

Quiscalus quiscula (Linn.). Purple Grackle.

Male.—Plumages, first, winter and nuptial.

The young birds molt the wing and tail along with the first body plumage and assume the adult plumage in its entirety the first winter. There is no spring molt and very little effect is produced by abrasion, owing to the uniform color of the plumage, so that the nuptial plumage is scarcely distinguishable from that of winter.

Female.—Molts as the male. Plumage always duller.

Family FRINGILLIDÆ.

A summary of the molting of the species of finches described below shows that thirteen species have no spring molt, while six species have a spring molt of the body feathers. In *Spinus tristis*, *Passerina cyanea*, *Ammodramus sandwichensis savanna*, *A. princeps* and *A. caudacutus*, this seems to occur regularly every year. In the first two a radical change of color is effected, in the last three the new plumage is the same as the old.

In *Habia ludoviciana* the extent of the molt varies, probably decreasing in succeeding years.

In four other species, *Zonotrichia leucophrys*, *Z. albicollis*, *Spizella socialis* and *Melospiza georgiana*, a partial spring molt occurs, less marked after the first year.

Habia ludoviciana molts the tail the first spring, *Ammodramus caudacutus* molts it in many cases though probably not regularly.

Cardinalis cardinalis molts both wing and tail with the first plumage at the end of summer and *Passerina cyanea* and *Ammodramus caudacutus* molt the tail at this time.

Carpodacus purpureus (Gmel.). Purple Finch.

Male.—Plumages, first, first winter, first nuptial, adult winter, adult nuptial.

I have not been able to examine any molting specimens of *Carpodacus*, but a large series of winter and spring specimens shows that no spring molt occurs. The change to the pink plumage is evidently effected at an annual molt either the second year or still later. The birds retain the brown dress during the first breeding season at least. Fall specimens in brown plumage differ from spring examples in the loss of buff tints through abrasion, while pink birds lose the gray or brown edgings of winter in the same way. The great predominance of brown birds makes it seem at least possible that some never acquire the pink plumage.

Female.—Retains the brown plumage permanently; there is no spring molt.

Pinicola enucleator (Linn.). Pine Grosbeak.

So far as I can judge from winter specimens the account of the Purple Finch applies equally well to this.

Loxia curvirostra minor (Brehm). American Crossbill.

Loxia leucoptera Gmel. White-winged Crossbill.

The molting of the Crossbills is more complicated than would appear at first sight and there is probably great individual variation as to the time and extent of the change in coloration of the plumage. Mr. W. E. D. Scott has shown that some males assume the red dress immediately upon losing the first plumage, while others are known to breed in the yellow or green dress. The tints are subject to great individual variation, as also the purity of the red plumage, many specimens showing a greater or less mixture of green. Furthermore, the red plumage may be partly replaced by green at a subsequent molt, as one molting specimen has the throat quite red while a majority of the new throat feathers, just coming in are green. The annual molt of the Crossbill begins about August 1, (Somerset Co., Maine). There seems to be a slight spring molt, most pronounced on the throat and breast.

Female.—Retains the green plumage at all seasons.

Acanthis linaria (Linn.). Redpoll.

While I have no molting specimens of the Redpoll for examination, I think from a comparison of a large winter series, that the change of plumage is effected in the same way as in *Carpodacus*. The variation in the extent of the pink color on the breast of males is probably largely individual.

It is generally stated that the crimson patch on the head is intensified by a "scaling off" of the surface of the feathers but I cannot furnish any evidence upon this point.

Spinus tristis (Linn.). American Goldfinch.

Male.—Three plumages are recognizable, first, winter and nuptial. The birds of the year seem to have more brown on the edges of the wing feathers which in the older birds are nearly pure white, but I am not sure that this is constant. Annual molt occurs between the middle of September and the middle of October, and at about the same time the young bird renews its body feathers. There is a complete molt of the body feathers in spring from about the middle

of April to the middle of May, but none of the wing feathers, not even the tertials, are renewed at this time. Throughout the winter and spring the white edgings to the tail and wing feathers are being lost by abrasion, so that in the summer breeding dress the wings are almost entirely black. The Goldfinch continues to have these two molts every year throughout its life, and the molting specimens present a very peculiar appearance in their mottled dress of brown and yellow.

Female.—The female has exactly the same number of molts and plumages as the male.

Spinus pinus (Wils.). Pine Siskin.

Plumages, first, winter and breeding.

So far as my material goes, there is indication of but one molt a year in this species, *i. e.*, the annual molt at the end of summer. Some abrasion takes place during the winter and spring, by which the buff edgings to the feathers are lost and the markings are thus intensified in the breeding plumage and more strongly contrasted with the white of breast. The white edgings to the wings are also lost by abrasion. A male taken Jan. 28th, (Cape May, N. J.), has the feathers of the throat and breast very much suffused with brown, so that the dark stripes are almost obliterated. Whether this is a peculiarity due to age or purely individual I am unable to say.

Plectrophenax nivalis (Linn.). Snow Bunting.

Male.—Plumages, first, winter and nuptial.

In the series which I have examined I have not detected any constant differences between the young of the year, and the adults. There seems to be no spring molt in the Snow Bunting, but the remarkable change from the winter to the nuptial dress is effected entirely by abrasion, which probably is more marked in this species than in any other. Furthermore, the abrasion is scarcely apparent until after the middle of February.¹⁹

Female.—Molts as in the male.

Pooecætes gramineus (Gmel.). Vesper Sparrow.

Plumages, first, winter and nuptial.

Molting exactly as in *Melospiza fasciata* which it so closely resembles in plumage. Young of the year seem rather buffer than old birds.

¹⁹ See Stone, Science, 1893, p. 52; Chapman, Bull. Amer. Mus. Nat. Hist., 1896, p. 9.

Ammodramus princeps (Mayn.). Ipswich Sparrow.

Plumages, first, winter and nuptial.

Molting exactly as in *A. sandwichensis savanna*. Specimens taken March 15th, Atlantic City, N. J. and March 29th, Cape Charles, Va., show the spring molt in progress.

Ammodramus sandwichensis savanna (Wils.). Savanna Sparrow.

Plumages, first, winter and nuptial.

Another winter plumage occurs much browner than the usual one which may be characteristic of the birds of the year. A complete annual molt occurs at the end of the breeding season, and a more or less complete molt of the body feathers takes place in spring. Birds taken just before the spring molt show effects of abrasion, especially on the tertials and resemble July birds. After the molt new tertials have been acquired and a general renewal of the feathers of the breast, head and rump has taken place, so that the birds are in most respects indistinguishable from September specimens; the yellow stripe over the eye is also acquired at this molt. Whether this spring molt is universal with all the individuals or occurs every year, I cannot say with certainty. A series of specimens taken January 25-26 (Cape May, N. J.), shows a good deal of variation in the amount of abrasion.

Ammodramus savannarum passerinus (Wils.). Grasshopper Sparrow.

Plumages, first, winter and nuptial.

After the annual molt the plumage of this species is subject to continued abrasion which materially alters the depth of colors by the following breeding season, the under surface becoming much lighter and losing much of the brown cast while the colors elsewhere are in sharper contrast. In such material as I have examined I can find no trace of a spring molt. The spotted first plumage is retained until about the middle of August. A specimen taken Aug. 10, in Chester Co., Pa., shows the beginning of the molt of the body feathers while another Aug. 26, from the same locality, shows no sign of molt, this, perhaps, belonging to a later brood.

Ammodramus henslowii (Aud.). Henslow's Sparrow.

Such specimens of this species as I have been able to examine indicate molts and plumages exactly parallel with the last.

Ammodramus caudacutus (Gmel.). Sharp-tailed Finch.

Plumages, first, winter and nuptial.

After the annual molt the Sharp-tailed Finch is subject to great abrasion of plumage, which by March presents almost as worn an

appearance as characterizes most birds in July or August. In April occurs a complete molt of the body plumage, together with the tertials and sometimes the rectrices; a specimen taken April 16 at Atlantic City, N. J., shows the new tail about half grown. After the completion of this spring molt the birds are indistinguishable, except upon close examination of the wing feathers, from October specimens. The feathers soon begin to show the effects of abrasion again and by August, just previous to the annual molt, the birds present about as dilapidated an appearance as can be found among any of our species. The wear and tear upon the plumage of this species is doubtless due to its habit of living entirely among the coarse grass and sedges of the salt marshes, which may also have something to do with the unusual extent of the spring molt. The young birds generally, but, perhaps not always, renew the tail when the first body plumage is molted at the end of summer. The remiges are not renewed at this time. The series of specimens, upon which the study of this species was based, consisted of upward of one hundred skins, taken at Atlantic City, N. J., during every month of the year by Mr. I. Norris De Haven and myself.

Ammodramus maritimus (Wils.). Seaside Finch.

Plumages, first, winter and nuptial.

In this species the spring plumage differs from the winter plumage only by abrasion, there being but one molt a year. Not only are the blending olive and brown tints of the fresh fall dress quite worn away, but the whole plumage presents the appearance of having been trimmed with a pair of scissors. It seems strange that in this species there should be no spring molt whatever, while in its nearest relative, the Sharp-tailed Finch, it should be so extensive.

Zonotrichia albicollis (Gmel.). White-throated Sparrow.

Male.—Five plumages may be distinguished, *i. e.*, first, first winter, first nuptial, adult winter, adult nuptial. The difference between second and third, and fourth and fifth is often very slight, especially in the case of the latter two. After the change to the first winter plumage the bird has a fairly well marked white throat, but the black crown stripes are much mixed with brown and the central stripe is quite dull. In spring a partial molt occurs, practically confined to the throat and head. At this time many black and pure white feathers appear in the crown, the yellow superciliaries receive bright fresh feathers and more pure white feathers are acquired on the throat. The black stripes of the crown are, how-

ever, still mixed with brown posteriorly, for the first season at least. Subsequently, whether at the following annual molt or later I cannot say, the plumage of the head becomes still brighter, with the crown stripes jet black reaching back on the neck while the white throat is sharply defined against dark gray cheeks and breast. I do not think there is any spring molt after the first year, but subsequent increase in the brightness of the markings takes place at the annual molt. The bright markings when once attained are not lost again, as some of the handsomest specimens examined are fall birds, although it is possible that some birds never acquire the brightest markings to which I have referred. Mr. W. E. D. Scott states that some birds acquire the highly colored feathers immediately after shedding the first plumage, judging the age of fall birds by osteological characters.

Female.—Apparently has no molt in spring, and though it attains the yellow eye-brow and partly black crown stripes, it does not approach the brilliancy of the old male.

Zonotrichia leucophrys (Forst.). White-crowned Sparrow.

Plumages, first, first winter, nuptial, adult winter.

Besides the annual molt, a molt of the crown, tertials and many of the breast and intescapular feathers occurs in spring. This is very marked in the first spring when the brown and buff crown is replaced by black and white. Whether it continues to the same extent in subsequent seasons I cannot say positively, though the appearance of spring specimens would indicate that some molt always occurred at this season. The full plumage once attained is not lost again, and spring and fall adults are hardly distinguishable.

Spizella monticola (Gmel.). Tree Sparrow.

Plumages, first, winter and nuptial.

There is only one molt a year, though a few odd feathers are often replaced during spring, probably when lost or damaged. Breeding specimens show great abrasion, which brings the colors into much stronger contrast, but this is not apparent until after April 1st, so that there is scarcely any variation in specimens taken within the winter habitat.

Spizella socialis (Wils.). Chipping Sparrow.

Plumages, first, winter and nuptial.

When the young bird loses the spotted first plumage, at the end of summer, it acquires a winter plumage practically identical with

that of the old birds except in the purity and extent of the chestnut crown. In spring the dusky feathers of the throat are replaced by pure white ones and those of the crown by new ones, which are richly colored and have no dark spots. Apparently the older birds do not molt at all in spring, the pure chestnut crown being gained entirely by abrasion of the dusky tips of the feathers. Adults vary, however, in the purity of the chestnut crown acquired at the annual molt, some of them showing much mottling of brown. In consequence of this a partial spring molt may be necessary in some individuals after the first season. Some change is effected in the other plumage during spring and winter by abrasion.

Spizella pusilla (Wils.). Field Sparrow.

Plumages, first, winter and nuptial.

After the annual molt the winter plumage changes gradually by abrasion, and there is no spring molt except the occasional renewal of odd feathers. The contrast between October and August specimens is striking. The former have the back buff with reddish-brown centers and black shaft streaks, while the latter have reddish-brown backs with distinct black streaks.

Junco hyemalis (Linn.). Snow Bird.

Plumages, first, winter, nuptial.

No spring molt is apparent in the Snow Bird. The brown tints of autumn disappear entirely through abrasion, but this is not marked until after May 1st. Birds of the year are probably always browner than old birds.

Melospiza fasciata (Gmel.). Song Sparrow.

Plumages, first, winter, nuptial.

No spring molt occurs but abrasion is very marked, all the buff tints being lost in the spring bird, while the black streaks on the breast appear as if their ends had been cut off with a pair of scissors.

Melospiza georgiana (Lath.). Swamp Sparrow.

Male.—Plumages, first, winter, nuptial.

The molt of this species appears to be precisely like that of *Spizella socialis*, which it so closely resembles in the pattern of its plumage. The chestnut crown is acquired in spring as well as a certain proportion of white throat feathers. The chestnut crown once acquired is not lost at the annual molt but some individuals do not seem to acquire it in its entirety, at least until the second year. No spring molt seems to occur after the full chestnut crown is attained. As

in most Fringillidæ, abrasion causes marked change in the general plumage during winter and spring.

Female.—Apparently like the male, though generally with the crown patch less pure.

Passerella iliaca (Merr.). Fox Sparrow.

Plumages, first, winter, nuptial.

Apparently no spring molt occurs in this species apart from a slight renewal of the throat feathers in some examples. The rusty red tints are to a great extent lost, especially on the head and neck, by the breeding season, but the abrasion is scarcely noticeable up to the time the bird leaves its winter habitat, so that specimens taken there, from November to March, are hardly distinguishable.

Pipilo erythrophthalmus (Linn.). Towhee.

Male.—Plumages, first, winter, nuptial.

There is apparently only one molt a year in the Towhee and, although the feathers are subject to abrasion during the winter and spring, scarcely any change is effected in the coloration owing to the fact that they are not parti-colored. The young birds assume the adult winter plumage about the end of August, when they present a very peculiar mottled appearance. The wing and tail as usual are not renewed at this time.

Female.—Molts as in the male, the only difference in plumage being the substitution of brown for black in the adult.

Cardinalis cardinalis (Linn.). Cardinal.

Male.—Plumages, first, winter, nuptial.

There is no spring molt; the winter plumage shows extensive gray margins to the feathers of the back which are lost by the nesting season through abrasion. In some specimens, evidently younger birds, these edgings are brownish rather than gray. Contrary to the rule which governs others of our Fringillidæ, the young Cardinal renews the rectrices and remiges at the end of the breeding season. A specimen obtained Sept. 18, 1881, at Haddonfield, N. J. shows the first plumage nearly lost. The primaries have all been renewed as far as the third, while the new tail, still showing the sheaths at base, is nearly full grown, except the middle pair of feathers, which are not quite two inches in length. The renewal of the flight feathers in the first autumn in this species is a matter of great interest (see p. 117).

Female.—Molts as in the male, a young female changing from the first to winter plumage (Tarpon Springs, Fla., Aug. 11, 1891),

shows the wings beginning to molt as described above in the case of the male. The adult plumages differ from those of the male in intensity of coloration, being generally gray and brown, though some Florida specimens are quite red. Much of the brown tint of the lower surface in winter is lost by abrasion.

Habia ludoviciana (Linn.). Rose-breasted Grosbeak.

The Rose-breasted Grosbeak exhibits probably the most complicated series of plumages of any of our smaller North American birds. Five regular plumages of the male and three of the female are recognizable, while the great range of individual peculiarity in the amount of change effected at a given molt produces many other variations.

I have treated the plumages and molts of this species at much length and have referred to them in other parts of this paper. As some of my deductions may not meet with universal endorsement, it seems proper to state at the outset the nature of the material at my disposal while writing the paper. This is as follows: First plumage, 1; first plumage, molting, 2. Males in first winter, 12; in first spring, 10; in first annual molt, 2; in second winter, 5; in second spring molt, 2; in second spring, 12. Females in spring, 8; annual molt, 1; winter, 2. Besides this, I have examined the entire series in the U. S. National Museum, the numbers of which I have not recorded.

Male.—There is in this species a complete annual molt and a more or less complete molt of the body feathers in early spring, generally including a molt of the tail in the first season. Much abrasion occurs between these two molts and in feathers not molted in the spring it continues until the next annual molt. The recognizable plumages are as follows:

First Plumage [30,236, Acad. Nat. Sci. Phila. July 1, 1892. Beaverkill, N. Y.].

Beneath white. Above, head dull black, with buffy superciliary and median stripes, all meeting on the hind neck. Rest of upper surface olive-brown, mottled with blackish-brown. Wing and tail (about half grown) olive-brown with spots and bands buffy-white.

First Plumage Molting [31,924, A. N. S. Phila. July 6, 1891. E. Hartford, Conn.].

Similar to the above, but with wings and tail of full dimensions, while the breast and abdominal tracts are newly molted buff feathers with dark centers. The head and throat are also beginning to change to the following plumage.

Plumage of First Winter [28,502, A. N. S. Phila. Aug. 10, 1879. Winnebago Co., Iowa].

Beneath buff, throat somewhat suffused with pink, and belly white, many of the feathers with a central dash of blackish-brown. Above much as in first plumage, but feathers of back and head more strongly edged with buffy-brown.

No specimens showing the molt from this plumage to that of the following spring have come under my observation; birds in the latter plumage are as follows.

Plumage of First Breeding Season [1,029 Coll. W. Stone].

Below, abdomen white, breast pink, throat black, mottled with pink and white. Above black, with more or less traces of buff edgings, rump white somewhat mottled with black, flight feathers generally as in first plumage, greater coverts and generally the tertials black, tail partly black.

Annual Molt [1,028, Coll. Wm. Brewster. Aug. 20, 1874. Upton, Oxford Co., Maine].

Below, as in the following specimen, but with many black feathers remaining on the throat, above as in first breeding plumage, except the back which has molted into fall plumage. Wings entirely molted except secondaries and outermost primaries. The old wing feathers are olive-brown, the new jet black.

Winter Plumage of Second Year [1,027, Coll. Wm. Brewster. Sept. 1871. Mt. Carmel, Ill.].

Differs from first fall plumage as follows: Belly whiter and throat and breast much more pink, feathers on back black, with comparatively narrow buff edgings. Wing and tail jet black, with pure white spots.

Breeding Plumage of Second Year [34,225, A. N. S. Phila. Haddonfield, N. J. May 16, 1882].

Differs from first year as follows: Throat uniform, black down to the breast, which is brilliant pink. Wings and tail jet black, with spots pure white, head and back solid black, rump pure white.

While the above descriptions give a pretty accurate idea of the seasonal variations of plumage in the Rose-breasted Grosbeak, they by no means cover all the peculiarities of plumage found in this variable species. It seems quite possible that the male requires three years to gain the perfect plumage described above as the "breeding plumage of the second year"; but different individuals differ so much in the amount of change that they undergo at the

spring molt, that they present an almost unbroken series from one extreme type of spring plumage to the other. It is, therefore, quite impossible to do more than separate them into two groups, with brown and black remiges respectively, the former representing one year old birds, the latter those of more than one year.²⁰

The remiges, I think, are only shed at the annual molt, as is the rule in nearly all passerine birds. The brown wing feathers of the fledgling are, therefore, retained until August of the next year. I think they are all replaced by jet black feathers at this annual molt. One spring specimen (1,029 Coll. W. Stone), it is true, has one black feather in an otherwise brown wing, but this is evidently an exception, and the black feather may have been assumed in spring; in any case, it can hardly be considered as evidence that the brown wings are retained for more than one year. Furthermore, all the brown-winged birds I have examined which show the annual molt in progress, have new black feathers coming in.

The tertials, as usual, do not accord with the primaries and secondaries in the time of their molt. Birds in the first winter plumage (*i. e.*, with brown wings) almost always molt the tertials with the body feathers in spring, the new ones being jet black with white spots. Two specimens before me, however, retained the old brown tertials throughout the breeding season. An example of the other extreme is a specimen (No. 501 Coll. W. Stone), a bird of the year, shot in September, which has just completed the molt from the first plumage to that of the first winter, has lost the brown tertials and greater wing coverts and has a new set of black ones which still have the embryonic sheaths adhering to the base of the quills.

Old birds, as a rule, do not renew the tertials in spring, though some of the most highly plumaged examples seem to have done so. In judging of the renewal of these tertials, I have based my opinion on the condition of these feathers in spring specimens. In some birds they are very much abraded so that the white spots appear to have been cut away, while in others they are fresh and show no abrasion at all (Pl. V, figs. 7 and 8). The former I regard as acquired at the previous annual molt and latter at the spring molt.

²⁰ As already stated, the most perfect plumage may not necessarily denote an old bird, but perhaps one of exceptional vitality. Though it is undoubtedly the fact that the successive plumages of an individual become more perfect, up to a certain point, at least, it is also quite likely that some individuals never reach the so-called perfect plumage.

The tail is generally shed at the first spring molt and a new black one assumed,²¹ though sometimes only a few of the feathers are changed, frequently only the middle pair. In these latter cases the complete black tail is assumed at the next annual molt.

As regards the spring molt of the body plumage there is a great deal of individual variation. In some specimens, especially in birds in their first spring plumage, this molt is practically complete, as far as the body feathers are concerned, while in others, a good many of the old feathers, showing much abrasion, are retained. This often gives a mottled appearance to the interscapular region, while in the pink breast patch the old feathers may be recognized by their worn whitish tips. One curious specimen (No. 31,922, A. N. S. Coll., E. Hartford, Conn., May 11, 1891), has the pink of the breast thickly spotted with black. Careful examination shows that but little molt has taken place on the breast; the buff margins, however, which bordered the feathers in the winter plumage, have been completely worn away, while the black portions being apparently less brittle have withstood the abrasion and remain as prominent as in the winter bird (see Pl. V, fig. 6). Furthermore, the feathers of the interscapular region, which are acquired at the spring molt, seem to vary in character, some are jet black throughout, while others are bordered with very light buff on the sides. These might be considered to be remnants of the winter plumage, but in many spring specimens (notably in 1,029, Coll. W. Stone, May 8, 1892) the feathers are fresh and perfect while if they had been acquired at the previous annual molt they would certainly have shown more or less abrasion. These buff-edged feathers in spring birds do not necessarily denote younger birds than those having the the pure black feathers, since in the specimen (28,499, Coll. A. N. S., June, 1881) which shows the least amount of spring molt of any in the series, such new feathers as have been acquired on the back are entirely black.

Female.—Molts and plumages quite different from male. So far as my material goes, there seems to be a partial molt in spring in addition to the annual molt at the end of the breeding season, but in many individuals the nuptial plumage is much abraded and shows but little renewal of the feathers. There is a curious plum-

²¹ I have not seen any specimen which shows this molt of the tail in progress, but I have seen such a specimen illustrating an exactly similar molt in *Piranga erythromelas*.

age of the female which I do not regard as belonging to the regular cycle of changes, but rather an abnormal tendency toward the color pattern of the male. This differs from the normal female plumage in having the head and forepart of the back, sides of neck, and chin black, slightly edged with gray, the median crown stripe being obsolete. Below white slightly tinged with yellow on the breast, where are also a few narrow shaft streaks. The specimen described was taken in Chester Co., Pa., May 5, 1888 (No. 1,957, Coll. W. Stone). A similar one is in the U. S. Nat. Museum Collection.

Passerina cyanea (Linn.). Indigo Bird.

Male.—Four distinct plumages are recognizable in this species.

First Plumage.

Much like the following but distinguished by the different structure of the feathers.

Plumage of First Winter. [No. 841, Coll. W. Stone. Sept. 30, 1891. Chester Co., Pa.].

Reddish-brown above, with darker shaft lines on back, below quite buff, brownish on breast, with distinct dark shaft lines.

Breeding Plumage.

Brilliant blue above and below, varying as described below.

Winter Plumage of Adult.

Reddish-brown above, shaft stripes obscure, rump feathers more or less blue with brown tips below, tinged with brown, many feathers with bluish bases, which give it a mottled appearance. Some specimens have much blue on the bases of all the feathers above.

The breeding plumage exhibits a great range of variation and the most brilliant and perfect dress is certainly not acquired before the second or third year. The primaries and secondaries are only renewed at the annual molt, but the tertials and some of the rectrices are often molted in spring, when the brown body feathers are lost and the blue plumage acquired. It is the irregularity in the extent of this molt that causes the variety in the breeding plumage of different individuals. Old brown tertials of the winter plumage are frequently retained through the breeding season and also many of the old coverts as well as brown patches or single feathers on various parts of the body. The white belly of the winter plumage also frequently escapes molt in the spring. Individual variation in the extent of the molt is so great that the specimens cannot be separated in definite groups. Fourteen spring and summer males

show only six in which the molt of body feathers has been complete and no trace of brown feathers remain, but even some of these have one or two brown wing-coverts. Eight of the fourteen have renewed the tertials in the spring molt while three have partially renewed them and three retain the old feathers. Winter specimens of more than one year also show a good deal of variation in the amount of blue on the feathers. Some which appear brown superficially, have the bases of the feathers quite blue; while others have broader brown margins and but little blue. Much abrasion takes place between the annual and spring molt but a scarcity of winter specimens and general lack of dates on such as I have, prevents a careful study of this matter. The young birds of this species molt the tail at the close of the summer when they renew their body plumage but do not molt the wing feathers.

Females.—Have but one molt a year, and the change in the nuptial plumage is due entirely to abrasion. Whether the young renew the tail at the end of the summer, as in the male, I am uncertain.

Spiza americana (Gmel.). Dickcissel.

Plumages, first, winter, nuptial.

No spring molt occurs in this species, unless in the first season.

Family TANAGRIDÆ.

Piranga erythromelas Vieill. Scarlet Tanager.

The seasonal changes of this species are analogous to those of the Rose-breasted Grosbeak, though the individual variations do not seem to be so great. Five regular plumages of the male are recognizable, as follows:

1. *First Plumage* [No. 1,906, Coll. W. Stone. Aug. 17, 1895. Chester Co., Pa.].

Above olive, below yellowish-white, yellow on middle of the abdomen and crissum, breast and sides of abdomen coarsely spotted and streaked with olive. Wings half grown, tail one-quarter grown.

2. *Plumage of First Winter* [No. 830, Coll. W. Stone. Sept. 18, 1891. Haddonfield, N. J.].

Above olive, below olive-yellow, wing and tail brown, edged with olive, except the greater median and lesser wing-coverts, which are jet black.

3. *First Breeding Plumage* [No. 34,001, Coll. A. N. S. Chester Co., Pa. May 18, 1881].

Above and below scarlet, tail jet black, wings brown, edged with olive, except greater median and lesser coverts and tertials which are jet black.

4. *Plumage of Second Winter* [No. 19,688, Coll. Wm. Brewster. Buncombe Co., N. C. Sept. 15, 1886].

Above olive, below yellow-olive, wings and tail entirely jet black.

5. *Breeding Plumage of Second Year* [No. 716, Coll. W. Stone. Harvey's Lake, Pa. June 16, 1891].

Above and below scarlet, wings and tail entirely jet black.

From these descriptions it will be seen that the dull brownish wing feathers of the first plumage are retained until the first annual molt, except the tertials which are molted in the spring when the red body plumage is first assumed. The jet black tail is also acquired at this time in all the specimens that I have examined, except one. In this the molt of the tail has been incomplete, only three black feathers having been assumed. In many birds in the first breeding plumage a few olive feathers persist on the sides of the body and flanks and more rarely on the back. Specimens in the plumage of the second winter also frequently show a few red feathers on these parts.

A peculiar plumage of the male which does not belong in the regular cycle, but which is of more than casual occurrence, has the scarlet of the normal plumage replaced by bright orange. Other peculiarities, which are of rather frequent occurrence, are the presence of red or orange feathers among the lesser wing coverts. Specimens taken in August, showing the annual molt in progress, are striking looking birds. One of these before me is about half molted; the crown, ear coverts, interscapulum, throat, sides of the abdomen, and spot on the breast are olive, while the hind neck, sides of head, rump, breast, center of abdomen and crissum are scarlet. Specimens showing the spring molt are, of course, exactly the reverse of this, but the only one that I have seen was so far advanced that nearly all the green plumage was lost. It was a bird entering upon its first spring, and showed the jet black tail about half grown while the brown remiges were retained and showed no signs of molt.

Specimens examined: First plumage, 1; first winter, 5; spring molt, 2; first breeding plumage, 14; annual molt 4; second winter 2; second spring molt, 1; second breeding plumage, 11.

Female.—I have been unable to examine any specimens in the winter, but from a comparison of spring and fall birds, I should

think there was at least a partial molt in spring.

Family AMPELIDÆ.

Ampelis cedrorum (Vieill.). Cedar Waxwing.

Plumages : first, winter, nuptial.

Only one molt a year occurs in this species and but little effect is produced by abrasion, except that the plumage becomes lighter, especially above. The molt is very late ; in a specimen taken Sept. 27, it has just begun while young birds molt the first plumage (?) of the body in November as shown in specimens taken Nov. 2-22.

Family HIRUNDINIDÆ.

The swallows exhibit certain peculiarities in their molt which have already been described (p. 111). In addition to this they differ from most Passerine species in having the first plumage better developed and more nearly like that of the adult. This plumage is generally retained much longer than in most birds and the young of most of our swallows seem to start on their migration with little or no molt having taken place. Sharpe and Wyatt think that swallows molt in their winter quarters, but in the case of *Tachycineta* and *Chelidon* this is certainly an error and Dr. J. A. Allen²² has shown that it is equally erroneous in the case of *Stelgidopteryx*. Some individuals probably start on their migration before the molt has begun. Certainly great quantities of swallows, mainly *Tachycineta* and *Chelidon*, congregate along the southern New Jersey coast in August, the majority of which are surely migrants, and many of them are molting. In the same way, molting *Tachycineta* occur in abundance in the lower Delaware Valley in October, where there are none in the summer. An adult *Chelidon erythrogaster*, taken at Philadelphia, Sept. 1, with the one described beyond, had just begun to molt on the head, but showed no trace of shedding any flight feathers. This bird would hardly have staid to molt, as this species is rarely seen here after that date.

Progne subis (Linn.). Purple Martin.

The Martin apparently has no regular spring molt, but some young males acquire scattered black feathers on the under parts at this time. The complete steel-blue plumage is not acquired till the end of the second summer (or perhaps the third?).

²² Auk, 1895, p. 374.

Petrochelidon lunifrons (Say). Cliff Swallow.

From such series of this bird as I have examined, I should judge that it had no spring molt; whether the young molt the flight feathers at the close of the summer I cannot say, as none of my specimens show any molt.

Chelidon erythrogaster (Bodd.). Barn Swallow.

The scarcity, in collections, of adults in winter plumage or in the molt prevents a complete account of the molting of this species. I have only one specimen showing the annual molt in progress, which was taken Aug. 7, 1878, at Philadelphia. New feathers are coming in on the breast, throat, and back, and the tail is just beginning to molt. None of the remiges have been cast. Another specimen, taken Sept. 1 at the same locality, shows a complete molt just finished. As I am not sure whether the young molts its flight feathers with the rest of its first plumage I cannot say whether this is an adult or bird of the year, but my impression is that the young do not molt the wing and tail at this time and that the specimen is, therefore, an adult. In any case it presents one curious question: The outer rectrices are only .35 in. longer than the next pair (as in all young summer birds). Now all the spring birds that I have examined have the feathers much longer (.75-1.25 in. longer than the next pair), so that there must be a molt of part of the tail at least, in the spring. I do not think there is any spring molt of the wings or body feathers.

Tachycineta bicolor (Vieill.). White-bellied Swallow.

Plumages: first, winter, nuptial, adult winter.

Male.—A large series of this species, collected in southern New Jersey illustrates the changes of plumage very satisfactorily. The annual molt in the adults takes place from July 20 to September 1, at which latter date the winter plumage is generally completed. The birds of the year do not begin to molt until the first week of September and are in full plumage, indistinguishable from the adults, by October 15. Apparently there is no spring molt, but the white tips to the wing feathers disappear by abrasion.

Female.—Two plumages of the female are found, one indistinguishable from the male, the other much duller and quite brown in the spring. The latter, I think, is the plumage of the first year; at any rate, in one specimen, it is certainly assumed at the molt of the first plumage.

Clivicola riparia (Linn.). Bank Swallow.

I can find no evidence of a spring molt in this species, but the plumage shows considerable abrasion at this season. I have seen no molting specimens.

Females.—Resemble the males at all times.

Stelgidopteryx serripennis (Aud.).

The above remarks apply equally to this species.

Family LANIIDÆ.

Lanius borealis Vieill. Northern Shrike.

There seems to be a partial molt in spring, but not extensive enough to produce a change in the plumage. One specimen, taken March 20, shows new feathers coming in on the breast and head.

Lanius ludovicianus Linn. Loggerhead Shrike.

A specimen taken October 20, Haddonfield, N. J. (No. 1,429, Coll. W.S.), which shows no sign of molt on the wings, except the tertials, and appears, therefore, to be a bird of the year, has nearly completed the body molt and has likewise renewed the tail. Spring specimens show a slight renewal of feathers, as in the preceding species.

Family VIREONIDÆ.

The uniform coloration of the feathers in the Vireos helps to obscure what little abrasion takes place in the plumage; and notwithstanding the fresh appearance of the spring dress, I do not think there is a spring molt of any great extent. The few winter specimens that I have examined show no signs of molt. The young in the first winter are like the adults, and the males and females are alike. There are, therefore, only three plumages: first, winter and nuptial, the last two are often scarcely distinguishable.

Vireo olivaceus (Linn.). Red-eyed Vireo.

Spring birds are, perhaps, duller colored, but show but little signs of wear. A specimen taken Aug. 27 has nearly completed the molt of body feathers while it is also molting the tail. The wings show no signs of molt, except the tertials which are generally renewed with the body plumage, so that the specimen must be a bird of the year.

Vireo gilvus (Vieill.). Warbling Vireo.

Vireo philadelphicus (Cass.). Philadelphia Vireo.

Molt as in the preceding. The winter plumages have respectively

more buff and olive-yellow beneath than the nuptial dress. No young birds in the first molt have been examined.

Vireo flavifrons Vieill. Yellow-throated Vireo.

Vireo solitarius (Wils.). Solitary Vireo.

These two birds seem to correspond exactly in the condition of their plumages. The tertials of some individuals show so little abrasion and have the light edgings so perfect that it seems as if they must be renewed in the spring. A young *V. flavifrons* in the first molt, is renewing only the body plumage.

Vireo noveboracensis (Gmel.). White-eyed Vireo.

A young bird in first molt is renewing its tail exactly as in *V. olivaceus*. Spring specimens show more abrasion than any of the other Vireos, and the edge of the tertials are very much worn, in striking contrast to the last two species.

Family MNIOTILTIDÆ.

A more or less complete spring molt of the body plumage seems to be the rule in the Warblers but as is usually the case with spring molts we have a very unsatisfactory series of specimens available for study, and are thrown back largely upon a comparison of spring and autumn material. Species of which I have actually seen specimens in the process of molting in spring are *Dendroica blackburniæ*, *D. discolor*, *D. castanea*, *D. palmarum*, *D. tigrina*, *D. coronata*, and *Geothlypis trichas*. The question of course arises as to the extent of this molt after the first year. The young of most Warblers in the first autumn differ materially from the adults, and an extensive molt is necessary in the following spring, but upon once gaining the adult plumage they do not change their appearance materially at the next annual molt and, therefore, a complete spring molt in subsequent years is not necessary. Some species, however, change regularly, twice a year. Probably nearly all Warblers have some spring molt, but in many it is restricted to the head and breast after the first season. Regarding the relation of their seasonal plumages, the species may be grouped as follows:

1. Adult male at all seasons and young of the year practically alike, *Seiurus*, *Helmitherus*, *Sylvania mitrata* (winter plumage with light tips on black parts).
2. Winter and nuptial dress of adult male different: *Mniotilta varia*, *Dendroica pensylvanica*, *D. maculosa*, *D. striata*, *D. castanea*, *D. blackburniæ*.

3. Adult males alike at all seasons, young of the year different : *Geothlypis*, *Sylvania canadensis*, *S. pusilla*, *Setophaga*, *Helminthophila pinus*, *H. ruficapilla*, *Dendroica aestiva*, *D. virens*, *D. caerulescens*, *D. vigorsii*, *D. tigrina*, *D. discolor*, *Compsothlypis*.

Regarding a few I am in doubt.

So far as I know, no Warblers molt the flight feathers in spring, nor do the young molt them with their first plumage.

Mniotilta varia (Linn.). Black and White Warbler.

Plumages : first, first winter, nuptial, adult winter.

Male.—The worn condition of the plumage of some birds would indicate that the spring molt is not as complete as in most Warblers. Some individuals do not molt the tertials at this time while others certainly do. The plumage of the first winter has only the sides of the body streaked and the streaks dull. The adult winter plumage is as heavily marked as the nuptial dress but has the throat white.

Female.—Remains in the plumage of the first winter.

Helminthophila pinus (Linn.). Blue-winged Warbler.

Plumages : first, first winter, first nuptial, adult winter, adult nuptial.

Male.—Spring birds are always much worn on the tertials and back, and probably have only a partial spring molt. The yellow cap is wanting in the first winter, the lores are dull and the under surface quite dull. Some spring males are dull and tinged with olive below, with the cap ill-defined, these I take to be first year birds. Adults are brilliant yellow.

Female.—Like male, with the same two forms of spring plumage.

Helminthophila chrysoptera (Linn.). Golden-winged Warbler.

Apparently the same plumages as the above. What I take to be the plumage of the first spring is tinted with yellow below. The female has the black replaced by gray.

Helminthophila ruficapilla (Wils.). Nashville Warbler.

Plumages : first, first winter, nuptial, adult winter.

The plumage of this species shows still more abrasion in spring, and there would seem to be little or no spring molt at this season, after the first year. Birds in the first winter lack the pure gray on the head, and show little or no chestnut on the cap.

Helminthophila peregrina (Wils.). Tennessee Warbler.

Apparently has the same number of plumages and molts as the last. Spring birds are much worn.

Helmitherus vermivorus (Gmel.). Worm-eating Warbler.

Plumages : first, winter, nuptial.

There is scarcely any variation in the plumage of this species after the nestling stage. Spring birds show but little abrasion.

Compsothlypis americana (Linn.). Parula Warbler.

Plumages : first, first winter, nuptial, adult winter.

The spring molt is probably not very marked, as the birds show much abrasion. Fall adults have the breast markings fringed with yellow, which is lost by the breeding season. How much variation there is in the nuptial plumage I cannot say. I had thought the dark-breasted individuals to be birds of the second or third year, but Mr. Brewster has shown that they represent a geographical race, *C. americana usneæ*. Perhaps the younger birds of this race will still be found to be lighter colored.

Dendroica tigrina (Gmel.). Cape May Warbler.

Plumages : first, first winter, nuptial, adult winter.

A nearly complete spring molt of body plumage takes place the first spring, and a good deal of abrasion follows during May, which brings out the spots on the back and throws all the markings into stronger contrast. Birds in the first winter are very dull and tinged with gray, while adults in winter differ little from spring birds, except that all the feathers are broadly bordered with olive-gray or yellow. This plumage changes to the adult nuptial dress wholly by abrasion, which is very strongly marked in spring adults.

Dendroica æstiva (Gmel.). Yellow Warbler.

Plumages : first, first winter, nuptial, adult winter.

There is a complete molt of body feathers the first spring, but it is probably not so extensive in subsequent years, as some spring birds show that the tertials have not been renewed. Young in first winter are very dull, with the top of the head quite green. Adults in winter are scarcely distinguishable from spring birds.

Dendroica cærulescens (Gmel.). Black-throated Blue Warbler.

Plumages : first, first winter, nuptial, adult winter.

The freshness of the flight feathers in some spring specimens seems to indicate that they are sometimes renewed with the rest of the spring plumage. Others are so worn that they probably molted but little at this time. Most fall adults have white edgings to the throat feathers, but others are absolutely indistinguishable from the the freshest spring specimens. Females are always in the brown

plumage, like the males in the first winter. One old (?) specimen (May 19, Coll. A. N. S., No. 29,592) is quite gray above.

Dendroica coronata (Linn.). Myrtle Warbler.

Plumages, first, first winter, nuptial, adult winter, adult nuptial.

A good series of winter and spring examples of this species from southern New Jersey shows the spring molt very satisfactorily. The entire plumage of the head and breast is renewed as well as the greater part of the interscapulum. The tertials are not molted. Old birds, in fall, have more or less gray feathers on the back and black centered feathers on the breast, but they all continue to molt in spring. A spring bird, which I take to be of the second or third year, has the black on the breast uniform, not broken up by white edgings to the feathers.

Dendroica maculosa (Gmel.). Magnolia Warbler.

Plumages and molts as in the last. Adults in winter differ from birds of the year in the heavy stripes on the sides of the body, and large black centers to feathers of the back. Spring birds of the second or third year have the interscapulum solid black, all the way to the yellow rump.

Dendroica pensylvanica (Linn.). Chestnut-sided Warbler.

Plumages, first, first winter, nuptial, adult winter.

Spring molt rather more extensive than in the last two species, and the adult in fall always more distinct from the nuptial plumage, only differing from the bird of the year in the chestnut stripes on the sides. The tertials are not renewed in spring.

Dendroica cærulea (Wils.). Cerulean Warbler.

According to the British Museum Catalogue, the winter adult is practically like the spring bird, so that the plumages will be as in *D. cærulescens*.

Dendroica castanea (Wils.). Bay-breasted Warbler.

Exactly like *D. pensylvanica* in number and relations of plumage.

Dendroica striata (Forst.). Black-poll Warbler.

Plumages, first, first nuptial, first winter, adult winter, adult nuptial.

This species, unlike the preceding, renews the tertials in spring. What I take to be the first nuptial plumage shows remains of the olive winter dress on the crown and sides of the neck. Adults

in fall are much whiter beneath than the young and have heavier streaks above. Females remain in a plumage like that of winter. I am uncertain as to the extent of molt in spring.

Dendroica blackburniæ (Gmel.). Blackburnian Warbler.

Plumages, first, first winter, nuptial, adult winter.

Some individuals molt the tertials in spring, others do not. Adults differ from young in winter, in the brighter yellow throat and breast.

Dendroica virens (Gmel.). Black-throated Green Warbler.

Plumages, first, first winter, nuptial, adult winter.

After the first season, the spring molt is much less extensive than in the species just preceding and in some individuals there seems to be little or no molt. Adults in fall have the black throat as in spring, but all the feathers are edged with white, which is afterwards lost by abrasion.

Dendroica vigorsii (Aud.). Pine Warbler.

Plumages, first, first winter, nuptial, adult winter.

After the first year there is little or no spring molt. Winter adults are nearly like summer examples.

Dendroica palmarum hypochrysea Ridgw. Yellow Palm Warbler.

Plumages, first, first winter, nuptial, adult winter.

The spring molt is restricted to the breast and crown, and the back shows much abrasion.

Dendroica discolor (Vieill.). Prairie Warbler.

Plumages, first, first winter, nuptial, adult winter.

The adult birds in autumn are practically like spring specimens but have the black stripes on the breast obscured by yellow edgings. Birds in their first winter plumage lack the chestnut on the back and have but few black streaks below. The tertials are not renewed in spring.

Seiurus aurocapillus (Linn.). Ovenbird.

Plumages, first, winter, nuptial.

Spring birds are practically indistinguishable from autumn examples and there is probably a pretty extensive spring molt. June and July specimens show much abrasion compared with those taken in April.

Seiurus noveboracensis (Gmel.). Water Thrush.

Seiurus motacilla (Vieill.). Louisiana Water Thrush.

The above remarks apply equally well to these species but with-

out a series of winter specimens it is impossible to ascertain the extent of spring molt in any *Seiurus*.

Geothlypis trichas (Linn.). Maryland Yellow-throat.

Plumages, first, first winter, nuptial, adult winter.

The spring molt seems confined to the breast, throat and sides of the head. Adults in winter have the hood much obscured by lighter edgings, while young have it reduced to a patch on the ear coverts and sides of neck.

Female.—Sometimes has no spring molt whatever.

Geothlypis philadelphia (Wils.). Mourning Warbler.

Plumages and molts apparently as in the preceding species.

Geothlypis agilis (Wils.). Connecticut Warbler.

Plumages and molts as in *G. trichas*. The spring molt is mainly restricted to the throat. Adults in spring and autumn are practically indistinguishable below, but the former show abrasion above. Young in the first winter have the throat and breast brownish instead of gray.

Geothlypis formosa (Wils.). Kentucky Warbler.

Plumages and molts as in *G. trichas*. I have no specimens of the young in their first winter and cannot say whether the black mask is complete then or not.

Icteria virens (Linn.). Yellow-breasted Chat.

Plumages, first, winter, nuptial.

There is scarcely any difference in spring and autumn specimens, except that the former show abrasion above. The spring molt is probably restricted to the under surface.

Sylvania mitrata (Gmel.). Hooded Warbler.

Plumages, first, winter, nuptial.

Mr. Wm. Palmer,²³ has shown that the male of this species acquires the full black hood the first year, and that the female varies in succeeding molts in the amount of black, finally attaining the full hood also.

Sylvania pusilla (Wils.). Wilson's Warbler.

Plumages, first, first winter, nuptial, adult winter.

Spring and fall adults are practically alike, and there is evidently a spring molt. Young of the year lack the black cap. Females

²³ Auk, 1894, p, 237.

have more or less black on the head and perhaps sometimes attain the full plumage of the male, as in the last species.

Sylvania canadensis (Linn.). Canadian Warbler.

Plumages and molts as in the last. The adult in autumn is exactly like the spring bird.

Setophaga ruticilla (Linn.). American Redstart.

Plumages, first, first winter, first nuptial, adult winter, adult nuptial.

Spring molt is mainly restricted to the under surface in the first season at least and probably afterward. Young in their first nuptial dress differ from that of the first winter only in the acquisition of a few scattered black feathers; new tertials are sometimes acquired in spring also. Some winter adults have gray edgings to the black feathers, others are indistinguishable from spring birds.

Family MOTACILLIDÆ.

Anthus pensilvanicus (Lath.). Tit Lark.

Plumages, first, winter, nuptial.

There is considerable molt of the body plumage in spring. Specimens taken in January and February are much abraded and resemble June birds.

Family TROGLODYTIDÆ.

Mimus polyglottos (Linn.). Mocking-bird.

Plumages, first, winter and nuptial.

There appears to be no spring molt, at least no specimens show traces of it. April birds show much abrasion, especially on the plumage of the back, and the buff tints of winter disappear entirely from the lower surface.

Galeoscoptes carolinensis (Linn.). Catbird.

Plumages and molt apparently as in the last. Some spring birds have the plumage quite fresh, but abrasion produces very little effect in this species, as shown by a comparison of spring and midsummer examples, so that I do not consider this as indicating a spring molt. Furthermore, none of the winter specimens examined show any indications of molt.

Harporhynchus rufus (Linn.). Brown Thrasher.

Plumages and molt as in *Mimus*. Spring birds are somewhat abraded, especially on the head, while the spots on the breast appear "clipped" at the tip and somewhat bifurcate. Some fall birds are

rather pruinose on the head and back. One of these specimens in the molt is proved to be an old bird, while other undoubted old birds have the more tawny plumage, so that I am not sure whether this slightly different coloration represents a bird of any particular age or is merely an individual variation.

Thryothorus ludovicianus (Lath.). Carolina Wren.

The molts and plumages of this bird are exactly parallel to those of *Harporhynchus rufus* and, so far as I can ascertain, there is no spring molt. The feathers of the crown are much abraded in all spring birds, and in late summer the abrasion of the entire plumage is extreme.

Troglodytes aëdon Vieill. House Wren.

Plumages, first, winter, nuptial.

There is no spring molt in the House Wren and the contrast between spring and fall specimens, caused by abrasion, is striking.

Troglodytes hiemalis Vieill. Winter Wren.

Plumages and molt exactly as in the House Wren.

Cistothorus stellaris (Licht.). Short-billed Marsh Wren.

Plumages, first, winter, nuptial.

There is a complete spring molt of the body feathers in this bird as shown in a series taken at Tarpon Springs, Fla., April 15th. They become very much abraded by July.

Cistothorus palustris (Wils.). Long-billed Marsh Wren.

Molts as in the preceding.*

Family PARIDÆ.

Sitta carolinensis Lath. White-breasted Nuthatch.

Plumages, first, winter, nuptial.

There is no spring molt, and, excepting on the flight feathers, abrasion is not very apparent until after the breeding season.

Sitta canadensis Linn. Red-bellied Nuthatch.

Molt as in the preceding.

Parus bicolor Linn. Tufted Titmouse.

Plumages, first, winter, nuptial.

No spring molt, and but little effect produced by abrasion.

Parus atricapillus Linn. Black-capped Chickadee.

Parus carolinensis Aud. Carolina Chickadee.

Molt as in the preceding, all plumages very similar to each other.

* *Certhia* apparently molts exactly as in *Troglodytes aëdon*.

Family SYLVIIDÆ.

Regulus satrapa Licht. Golden-crowned Kinglet.

Plumages, first, winter, nuptial.

No spring molt.

Regulus calendula (Linn.). Ruby-crowned Kinglet.

Plumages and molt as in the last. Mr. C. W. Beckham²⁴ states that the young male generally acquires the red crown patch when the first plumage is molted but not always, and that the female never acquires it. Several variations in the color of the red patch have also been described.

Polioptila cærulea (Linn.). Blue-gray Gnatcatcher.

Plumages, first, winter, nuptial.

While none of the February or April specimens show signs of molt, I think that some individuals have a partial molt in spring and I have examined a specimen of *P. albiventris* Lawr., showing the spring molt in progress (March 19th.).

Family TURDIDÆ.

Turdus mustelinus Gmel. Wood Thrush.

Plumages, first, winter, nuptial.

Although I have no winter or early spring specimens of the Wood Thrush, I consider that there is only a slight spring molt if any.

Turdus aliciaë Baird. Gray-cheeked Thrush.

Turdus ustulatus swainsonii (Cab.). Olive-backed Thrush.

The above remarks apply equally to these species.

Turdus aonalaschkæ pallasii (Cab.). Hermit Thrush.

I have examined a large series of Hermit Thrushes, including winter specimens, and can find no traces of a spring molt. The abrasion is more marked than in the last two species.

Turdus fuscescens Steph. Wilson's Thrush.

Plumages and molt as in the preceding.

Merula migratoria (Linn.). Robin.

Sialia sialis (Linn.). Bluebird.

Plumages, first, winter and nuptial.

No spring molt occurs, but some abrasion is seen in spring birds.

²⁴ Proc. U. S. Nat. Mus., 1885, p. 625.

EXPLANATION OF PLATES.

PLATE IV.

- Fig. 1. Wing of *Merula migratoria* with molt started; shaded parts represent the new feathers. Quill No. 6 has been shed but the new feather has not yet appeared.
- Fig. 2. Wing of *Tachycineta bicolor*; molt of primaries well advanced.
- Fig. 3. Wing of *Chætura pelagica*, with molt of primaries well advanced.
- Fig. 4. Tail of *Tachycineta bicolor*, with molt of rectrices half completed.
- Fig. 5. Breast feather of *Antrostomus vociferus*, first plumage, bearing a down feather at its tip (much enlarged).
- Fig. 6. Tip of breast feather in sheath of *Sturnella magna*, winter plumage; forcing out a first plumage feather on its tip (enlarged).
- Fig. 7. Feather from breast of *Dolichonyx oryzivorus* Ad. ♂ showing light border which is lost by abrasion.
- Fig. 8. Terminal part of tertial of *Sturnella magna*, winter plumage.
- Fig. 9. Same in late summer, showing loss of entire terminal portion even with the tips of the secondaries; also loss by abrasion of all the light border and spots, including the entire terminal part of the barbs, from where the light color begins to their extremities.

PLATE V.

- Fig. 1. Tail of *Dryobates pubescens* showing the beginning of the molt. The third quill has just been shed and the tip of the new one has not yet appeared.
- Fig. 2. Tail of *Galeoscoptes carolinensis* showing the molt under way.
- Fig. 3. Wing of *Ceryle alcyon* showing the beginning of the molt with the fourth primary, instead of the innermost as is usually the case.
- Fig. 4. Wing of *Plectrophenax nivalis* with molt of primaries and tertials in progress.
- Fig. 5. Wing of *Dendroica aestiva* showing molt of primaries and tertials almost complete, while the secondaries are about half grown. Dotted line represents the position of feathers when the growth is completed.

- Fig. 6. Feather from breast of *Habia ludoviciana* showing the unworn projecting black tip. Dotted line indicates the original size of feather, the edge having been lost by abrasion (enlarged).
- Fig. 7. Terminal portion of tertial of *Habia ludoviciana* in winter plumage showing white border spot.
- Fig. 8. Same from spring specimen with white portion lost by abrasion.